PM-9000

Patient Monitor

Operation Manual

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CE 0123

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FOR YOUR NOTES

Preface

Manual Purpose

This manual provides the instructions necessary to operate the PM-9000 Patient Monitor (hereinafter called as this monitor) in accordance with its function and intended use. Observance of this manual is a prerequisite for proper performance and correct operation, and ensures patient and operator safety.

This manual is written based on the maximum configuration. Part of this manual may not apply to your monitor. If you have any question about the configuration of your monitor, please contact our Customer Service.

This manual is an integral part of and should always be kept close to the patient monitor, so that it can be obtained conveniently when necessary.

Intended Audience

This manual is geared for the clinical medical professionals. Clinical medical professionals are expected to have working knowledge of medical procedures, practices and terminology as required for monitoring of critically ill patients.

Version Information

This manual has a version number. This version number changes whenever the manual is updated due to software or technical specification change. Content of this manual is subject to change without prior notice. The version information of this manual is as follows.

Version number	Release date
6.2	December, 2006

Illustrations and Names

All illustrations in this manual are provided as examples only. They may not necessarily accord with the graph, settings or data displayed on your patient monitor.

All names appeared in this manual and illustrations are fictive. It is a mere coincidence if the name is the same with yours.

Conventions

- ***Italic*** text is used in this manual to quote the referenced chapters or sections.
- The terms danger, warning, and caution are used throughout this manual to point out hazards and to designate a degree or level or seriousness.

1 Safety

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1.1 Safety Information

The safety statements presented in this chapter refer to the basic safety information that the operator of the patient monitor shall pay attention to and abide by. There are additional safety statements in other chapters or sections, which may be the same as or similar to the followings, or specific to the operations.

⚠DANGER

- **Indicates an imminent hazard situation that, if not avoided, will result in death or serious injury.**

⚠WARNING

- **Indicates a potential hazard situation or unsafe practice that, if not avoided, could result in death or serious injury.**

⚠CAUTION

- **Indicates a potential hazard or unsafe practice that, if not avoided, could result in minor personal injury or product/property damage.**

NOTE

- **Provides application tips or other useful information to ensure that you get the most from your product.**

1.1.1 Dangers

There are no dangers that refer to the product in general. Specific “Danger” statements may be given in the respective sections of this operation manual.

1.1.2 Warnings

⚠WARNING

- **The device is intended for use by qualified clinical physicians or well-trained nurses in the specified places.**
- **To ensure patient safety, verify the device and accessories can function safely and normally before use.**
- **EXPLOSION HAZARD: Do not use this device in the presence of flammable anesthetics, explosive substances, vapors or liquids.**
- **You must customize the alarm settings according to the individual patient situation, and make sure the alarm sound is activated when an alarm occurs.**
- **ELECTRIC SHOCK: Do not open the monitor housing. All servicing and future upgrades to this device must be carried out by personnel trained and authorized by our company only.**
- **DEFIBRILLATION: Do not come into contact with the patient during defibrillation. Otherwise serious injury or death could result.**
- **When used in conjunction with electro-surgery equipment, you must give top priority to the patient safety.**
- **DISPOSE: Dispose of the package material, observing the applicable waste control regulations and keeping it out of children’s reach.**
- **The device must be connected to a properly installed power outlet with protective earth contacts only. If the installation does not provide for a protective earth conductor, disconnect the monitor from the power line and operate it on battery power, if possible.**

1.1.3 Cautions

⚠CAUTION

- **To ensure patient safety, use only parts and accessories specified in this manual.**
- **Remove the battery from the patient monitor if it will not be used or not be connected to the power line for a long period.**
- **Disposable devices are intended for single use only. They should not be reused as performance could degrade or contamination could occur.**
- **At the end of its service life, the product described in this manual, as well as its accessories, must be disposed of in compliance with the guidelines regulating the disposal of such products. If you have any questions concerning disposal of the products, please contact with us.**
- **Magnetic and electrical fields are capable of interfering with the proper performance of the device. For this reason make sure that all external devices operated in the vicinity of the monitor comply with the relevant EMC requirements. Mobile phone, X-ray equipment or MRI devices are a possible source of interference as they may emit higher levels of electromagnetic radiation.**
- **Before connecting the patient monitor to the power line, check that the voltage and frequency ratings of the power line are the same as those indicated on the label or in this manual.**
- **Install or carry the patient monitor properly to avoid damages caused by drop, impact, strong vibration or other mechanical force.**

1.1.4 Notes

NOTE

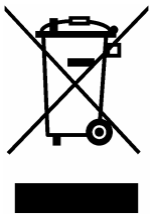
- **Keep this manual close to the patient monitor so that it can be obtained conveniently when necessary.**
- **This patient monitor complies with the requirements of CISPR11 (EN55011) class A.**
- **The software was developed per IEC601-1-4. The possibility of hazards arising from errors in software program is minimized.**
- **Put the patient monitor in a location where you can easily see the screen and access the operating controls.**
- **The instructions of this manual are based on the maximum configuration. Some of them may not apply to your patient monitor.**

1.2 Equipment Symbols

NOTE

- **Some symbols may not appear on all equipment.**

	Attention: Consult accompanying documents (this manual).
	Power ON/OFF
	Alternating current (AC)
	Type CF applied part. The unit displaying this symbol contains an F-type isolated (floating) patient part providing a high degree of protection against shock, and is suitable for use during defibrillation.
	TYPE BF applied part. Defibrillator-proof protection against electrical shock.
	Equipotentiality
	Gas inlet
	Gas outlet
	Auxiliary output
	Network connector
	VGA connector
	Manufacture date

SN	Serial number
EC REP	European community representative
CE 0123	This mark means that this device is fully in conformance with the Council Directive Concerning Medical Devices 93/42/EEC. The number adjacent to the CE marking (0123) is the number of the EU-notified body that certified meeting the requirements of Annex II of the Directive.
	The following definition of the WEEE label applies to EU member states only. This symbol indicates that this product should not be treated as household waste. By ensuring that this product is disposed of correctly, you will help prevent bringing potential negative consequences to the environment and human health. For more detailed information with regard to returning and recycling this product, please consult the distributor from whom you purchased it. * For system products, this label may be attached to the main unit only.

1.3 CE Marking



The patient monitor bears CE mark indicating its conformity with the provision of Council Directive 93/42/EEC concerning medical devices, and fulfills the essential requirement of Annex I of this directive.

The patient monitor is in radio-interference protection class A in accordance with EN55011.

The product complies with the requirement of standard EN60601-1-2 "Electromagnetic Compatibility – Medical Electrical Equipment".

1.4 Reference Literature

1. Medical Device Directive 93/42/EEC
2. EN60601-1+A1+A2 or IEC60601-1+A1+A2, Medical Electrical Equipment, Part 1: General Requirements for Safety
3. EN60601-1-1 or IEC60601-1-1, Medical Electrical Equipment- Part 1-1: General Requirements for Safety - Collateral Standard: Safety Requirements for Medical Electrical Systems
4. IEC60601-1-4, Medical Electrical Equipment- Part 1-4: General Requirements for Safety - Collateral Standard: Programmable Electrical Medical Systems
5. IEC60601-2-49 Medical Electrical Equipment-Part 2-49: Particular Requirements for the Safety of Multifunction Patient Monitoring Equipment

2 The Basics

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2.1 Monitor Description

This monitor integrates the functions of parameter measurement, waveform monitoring, freezing, and recording, etc. Its color TFT liquid crystal display is able to show patient parameters and waveforms clearly. The monitor also features compact size, lightweight, easy-to-carry handle and built-in battery, which make it portable, especially in hospital transport. The compact control panel and control knob, and the easy-to-use menu system enable you to freeze, record, or perform other operations conveniently. Besides, this monitor can be connected with the central monitoring system whereby a monitoring network will be formed.

2.1.1 Intended Use

The intended use of this monitor is to monitor a fixed set of parameters (see ***2.1.4 Functions***) for single adult, pediatric and neonatal patient, to display patient data and waveforms, to store patient data in a trend database, and to generate alarms and recordings.

This monitor is to be used in but not restricted to medical institutions such as ICU, CCU, cardiopathy ICU, operating room, emergency room and postoperative observation ward etc. This monitor may also be used during hospital transport or ambulance. This monitor is not intended for helicopter transport or home use.

⚠WARNING

- **This Monitor is to be operated by clinical physicians or appropriate medical staffs under the direction of physicians. The operator of the monitor must be well trained. Any operation by unauthorized or non-trained personnel is forbidden.**
- **The physiological waveforms and parameters and the alarm information displayed by the monitor are only for the reference of physicians, but cannot be used directly to determine the clinical treatment.**

2.1.2 Contraindications

None.

2.1.3 Components

This monitor consists of parameter measuring modules, blood pressure cuff, ECG, IBP and CO cables, SpO_2 sensors, CO_2 and AG measuring components. Some of the components are optional and may not apply to your patient monitor.

2.1.4 Functions

This monitor is capable of monitoring the following parameters.

- ECG Heart rate (HR)
  2 channels of ECG waveforms
  Arrhythmia and ST segment analysis (optional)
  Pace analysis (PACE)

- RESP Respiration rate (RR)
  Respiration waveform

- SpO_2 Oxygen saturation (SpO_2)
  Pulse rate (PR)
  SpO_2 plethysmogram

- NIBP Systolic pressure (NS), diastolic pressure (ND), mean pressure (NM)

- TEMP Temperature of channel 1 (T1), temperature of channel 2 (T2), and temperature differential between two channels (TD)

- IBP 2 channels of IBP waveforms
  Systolic (SYS), diastolic (DIA), and mean (MEAN) pressure.

- CO Temperature of blood (TB)
  Cardiac output (CO)

- CO_2 End-tidal carbon dioxide ($EtCO_2$)
  Fractional inspiratory carbon dioxide ($FiCO_2$)
  Air-way Respiration Rate (AwRR)

- AG Fraction of inspired carbon dioxide, nitrous oxide, oxygen or anesthetic gas ($FiCO_2$, FiN_2O, FiO_2, FiAA), and End-tidal carbon dioxide, nitrous oxide or oxygen ($EtCO_2$, EtN_2O, EtO_2, EtAA)
  AA refers to one of the following anesthetic agents:
  HAL (Halothame)
  ISO (Isoflurane)
  ENF (Enflurane)
  SEV (Sevoflurane)
  DES (esflurane)
  Airway respiration rate (AwRR)
  Minimum alveolar concentration (MAC)
  4 channels of AG waveforms (CO_2, N_2O, O_2 and AA)

This monitor has additional functions including visual & audible alarms, freezing, data storage and output, recall, recording and drug calculation etc. Please refer to the following corresponding chapters for details of each specific function.

2.2 External Appearance

2.2.1 Front Panel

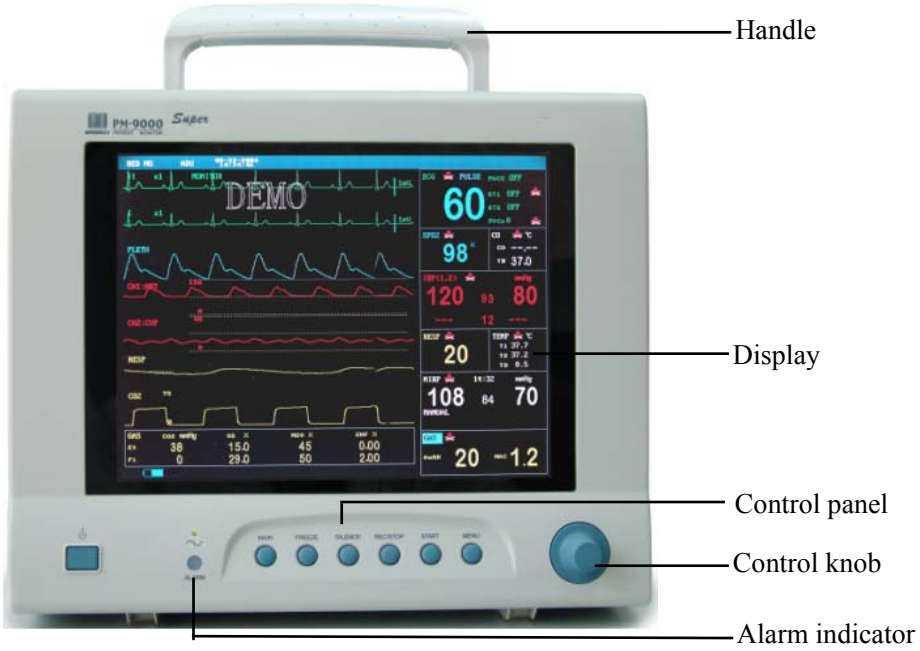


Figure 2-1 Front Panel

This monitor is designed to comply with the requirements of relative international safety standards (IEC60601-1, EN60601-2-27 and EN60601-2-30) for medical electrical equipment. This monitor has floating inputs and is protected against the effects of defibrillation and electrosurgery. When proper electrodes are used and applied according to the manufacturer instructions, the screen display will recover within 10 seconds after defibrillation.

The alarm indicator of this monitor complies with the requirement of EN60825-1 A11 Class 1 for LED. The LED indicator varies its flash color and frequency to indicate different alarm levels. For details, please refer to the section of ***6.2.1 Visual Alarms***.

⚠WARNING

- **Move or lift the monitor by the handle only. Do not use the patient cable or the power cord to move or lift the monitor. It might cause the monitor to fall, which might damage the monitor or injure the patient.**

2.2.2 Side Panel

On the left side of the monitor, you can find the following connectors and the battery compartment.

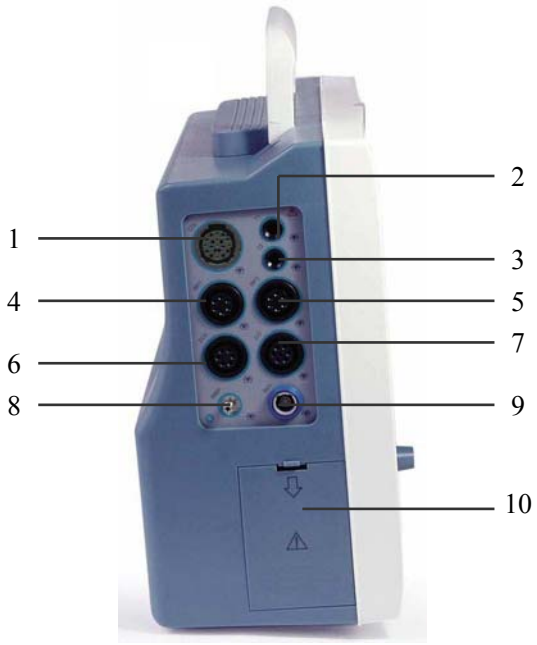


Figure 2-2 Left Side Panel

1. CO_2: CO_2 sensor connector (Welch Allyn CO_2 module)
2. T1: Temperature probe connector (channel 1)
3. T2: Temperature probe connector (channel 2)
4. IBP1: IBP transducer connector (channel 1)
5. IBP2: IBP transducer connector (channel 2)
6. ECG: ECG cable connector
7. CO: CO cable connector
8. NIBP: NIBP cuff hose connector
9. SpO_2: SpO_2 sensor connector
10. Battery door

On the right side of the monitor, you can find the connector for Oridion or Mindray CO_2 module or AG module. The recorder is located at the bottom of the right side.

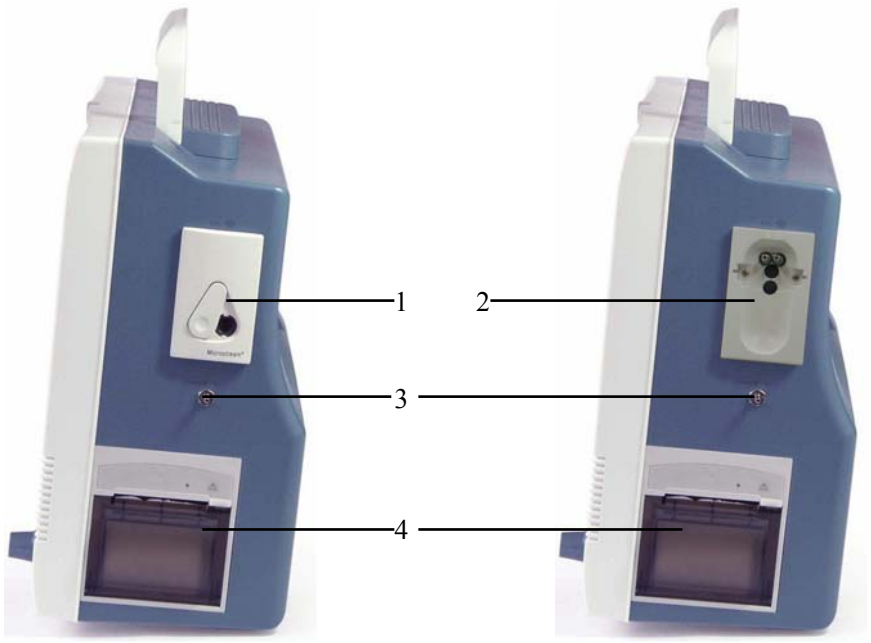


Figure 2-3 Right Side Panel

1. CO_2: CO_2 sensor connector (Oridion CO_2 module)
2. Water trap connector (Mindray CO_2 or AG module)
3. Exhaust outlet
4. Recorder

NOTE

- **Some modules are optional. Their connectors may not be available on your patient monitor.**
- **Your monitor can be equipped with Oridion, Welch Allyn or Mindray CO_2 module. As shown in Figure 2-2 and Figure 2-3, they are located in different position and have different appearance. For one monitor, only one CO_2 module can be equipped.**
- **If your monitor is equipped with Mindray CO_2 module, then it can't be equipped with AG module, vice versa.**

2.2.3 Rear Panel

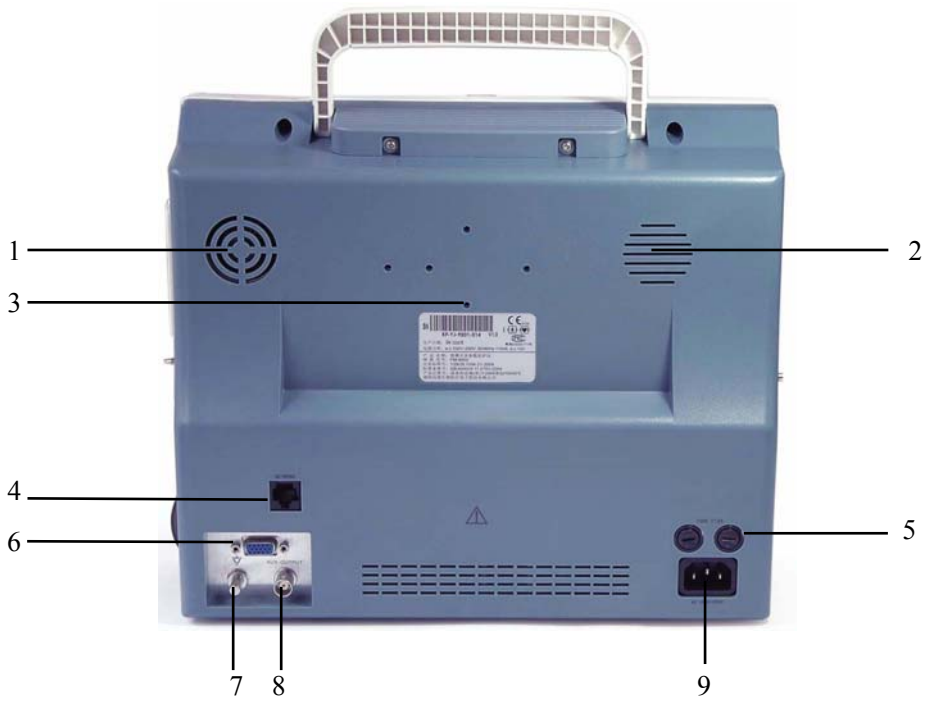


Figure 2-4 Rear Panel

1. Fan Vent

2. Speaker holes

3. Mounting holes for support bracket.

4. Network Connector: Standard RJ45 connector.

Through network connector, this monitor can be connected with the central monitoring system, another monitor, or a PC. It enables the functions of viewbed monitoring, data output and on-line software upgrading.

5. Fuse: Standard T3.0A

6. VGA Monitor Connector

A standard color VGA monitor can be connected to the patient monitor through this connector.

7. Equipotential grounding connector

8. Auxiliary Output Port: A standard BNC connector.

It is the common interface of analog output signals, nurse call output signals or defibrillator synchronization signals. You can manually select the function of this port in the USER MAINTAIN menu, please refer to ***4.7 Maintenance*** for details.

9. AC Power Input Connector

A three-wire power cord can be connected to this receptacle to provide AC power supply to the patient monitor.

To know details about the connections of the connectors, please refer to ***3.1 Installation***.

⚠WARNING

- **Accessory equipments connected to this patient monitor must be certified according to the respective IEC standards (e.g. IEC 60950 for information technology equipment and IEC 60601-1 for medical electrical equipment). Furthermore all configurations shall comply with the valid version of the system standard IEC 60601-1-1. Any person who connects additional equipment to the signal input or signal output is responsible to ensure the system complies with the requirements of the valid version of the system standard IEC 60601-1-1. If in doubt, contact our company or customer service.**

2.3 Control Panel

The control panel as shown below is located at the bottom on the front panel. On the control panel are the following keys and indicator.

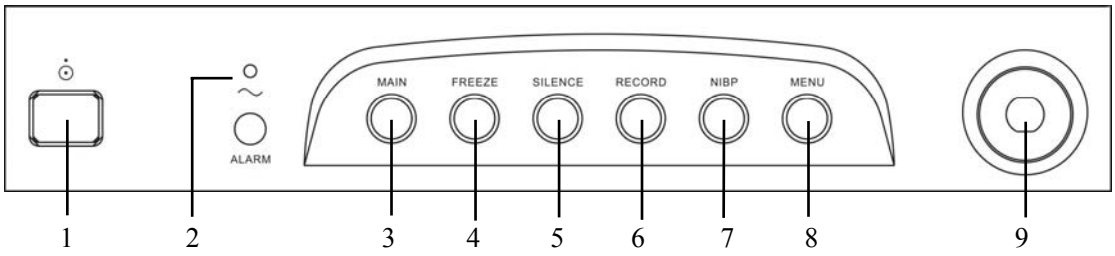


Figure 2-5 Control Panel

1. Power switch

This key turns the monitor ON and OFF. To turn OFF the monitor, please press this key and hold for more than 2 seconds.

2. AC power indicator

- ON: AC power is applied to the monitor.
- OFF: AC power is not applied to the monitor.

3. MAIN

Press this key to exit the menu currently displayed, and return to the main screen.

4. FREEZE

This key is pressed to freeze and unfreeze waveforms. See ***7 Freezing Waveforms*** for more information.

5. SILENCE

You can press this key to pause alarms, silence the monitor or clear alarms. You can also switch between different alarm statuses through this key. See ***6.3.5 Status Switchover*** for more information.

6. RECORD

Press this key to start or stop recording. See ***8 Recording*** for more information.

7. NIBP

Press this key to start or stop the non-invasive blood pressure measurement. See ***13***

NIBP Monitoring for more information.

8. MENU

Press this key to display the SYSTEM MENU, as shown in Figure 4-1.

9. Control Knob

The main operator control is the control knob. The control knob rotates in either direction to highlight parameter labels and menu options. After highlighting the desired selection, press the control knob to execute an operation, make a selection, view a new menu or a small drop-down list. This procedure is referred to as “select ” through out the manual. Remember rotate to highlight, and then press to select.

2.4 Display

This monitor has a color TFT LCD display of high resolution. It is able to display patient parameters and waveforms clearly. The following is the standard interface when the monitor is operating normally.

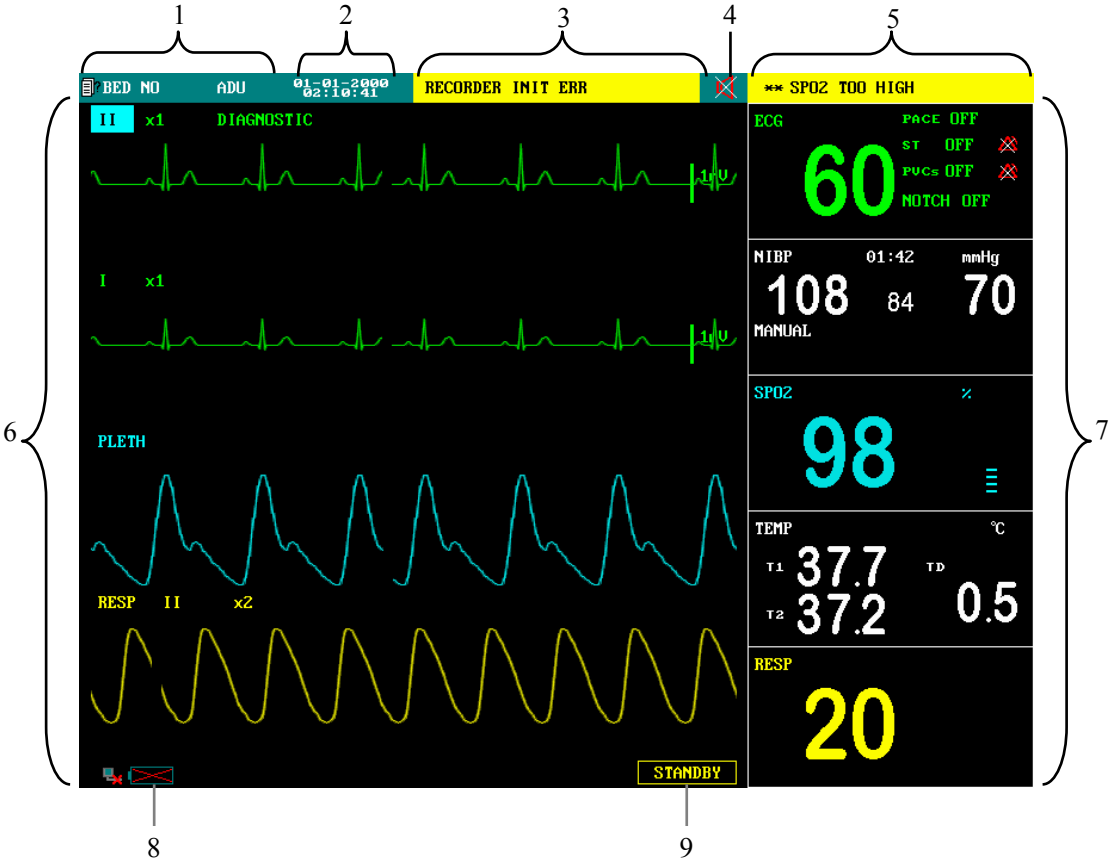


Figure 2-6 Main Screen

1. Patient information area

It displays patient bed number and patient type. If no patient is admitted, it displays "NO PATIENT ADMITTED". If the patient's information is incomplete, corresponding symbols will be displayed.

2. System time

The system time of the monitor is displayed in two lines. The time format can be set in the TIME SETUP menu. For details, see ***4.4.3 Time Setup***.

3. Technical alarms area

Technical alarm messages or prompt information are displayed in this area. In case of multiple messages, they will be displayed alternately. This area shows the patient

name and sex when no message is to be displayed.

4. Sound icon

Alarms Paused ; System Silenced; Alarms Silenced. No icon is displayed under normal status. For more information, see ***6.3 Alarm Statuses***.

5. Physiological alarms area

Physiological alarm messages are displayed in this area. In case of multiple messages, they will be displayed alternately.

6. Waveforms area

For the maximum configuration, at most seven waveforms can be displayed in the waveforms area, including two ECG waveforms, one SpO_2 plethysmogram, two IBP waveforms, one CO_2 waveform and one RESP waveform. In HALF-SCREEN MULTI-LEADS display mode, a maximum of ten waveforms can be displayed, among which six are ECG waveforms. You may select the waveforms to be displayed and adjust the display positions. For details, see ***4.4.8 Trace Setup***.

7. Parameter windows

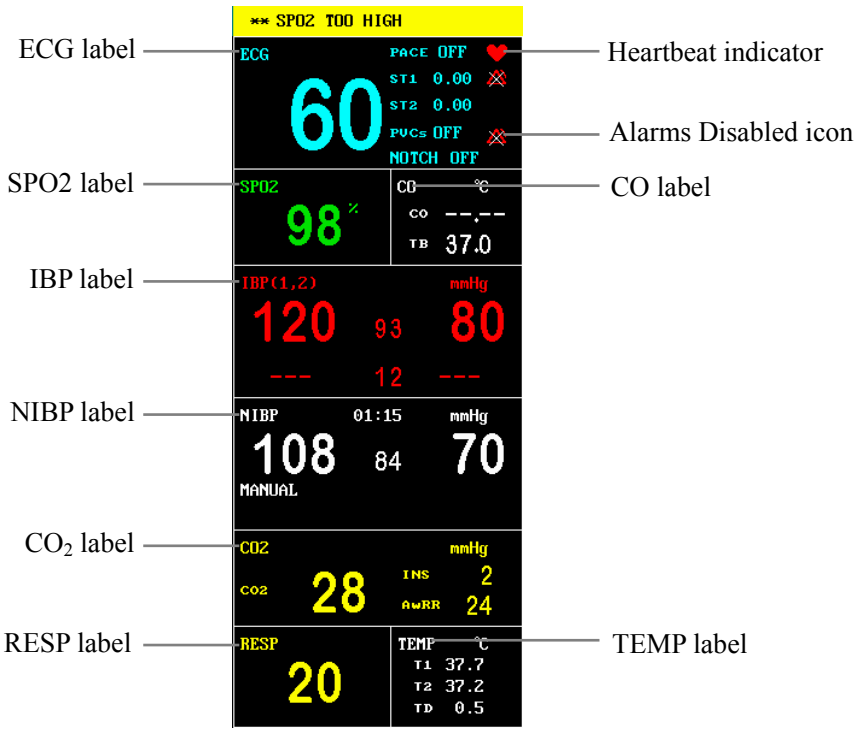


Figure 2-7 Parameter Windows

The parameter windows are located on the right of the waveform area, and are divided by white lines. Each window is identified by a parameter label on the upper

left.

You may select a parameter label to open the setup menu of this parameter. Each of the parameter is described in more detail in the following chapters. If you select to turn OFF the alarm of a parameter in its corresponding setup menu, an Alarms Disabled icon will be displayed aside the parameter label. For more information, see ***6.3.1 Alarms Disabled***.

8. Prompt information area

The battery symbol in this area displays the status of the battery. For more information, please refer to ***2.5 Batteries***.

Upon turning ON the monitor, prompt information, for example “NIBP alarm disabled”, will cover the battery symbol.

9. STANDBY label

You may select this label to enter the standby mode. For more information, please refer to ***5.6 Standby Mode***.

2.5 Batteries

This monitor is designed to operate run battery power when during transport or whenever the power supply is interrupted. The battery is charged automatically when the monitor is connected to AC power, no matter the monitor is powered on or not.

The battery symbol displayed on the main screen tells the status of the battery.

-  The battery is installed in the battery slot.
  The solid part indicates its capacity.
-  No battery is installed in the battery slot.

The capacity of the internal battery is limited. When the battery capacity is too low, a high level alarm is triggered and the "Battery two low" message is given in the technical alarms area. At this moment, the AC power shall be applied to the monitor.

For details about installation of the battery, refer to the section ***3.1.5.2 Installing the Battery***.

NOTE

- **Remove the battery before transport, or if the monitor is not likely to be used for an extended period of time.**

⚠WARNING

- **Keep the battery out of the reach of children.**
- **Use only the battery specified by the manufacturer.**

2.5.1 Battery Maintenance

2.5.1.1 Conditioning a Battery

A battery should be conditioned before it is used for the first time. A battery conditioning cycle is one uninterrupted charge of the battery, followed by an uninterrupted discharge of the battery. Batteries should be conditioned regularly to maintain their useful life. Condition a battery once when it is used or stored for two months, or when its run time becomes noticeably shorter.

To condition a battery, follow this procedure:

1. Disconnect the monitor from the patient and stop all monitoring or measuring.
2. Insert the battery in need of conditioning in the battery slot of the monitor, and leave the other slot empty if your monitor has two slots.
3. Apply AC power to the monitor and allow the battery to charge uninterrupted for 10 hours.
4. Remove AC power and allow the monitor to run from the battery until it shuts off.
5. Apply AC power again to the monitor and allow the battery to charge uninterrupted for 10 hours.
6. This battery is now conditioned and the monitor can be returned to service.

2.5.1.2 Checking a Battery

The performance of a rechargeable battery may deteriorate over time. To check the performance of a battery, follow this procedure:

1. Disconnect the monitor from the patient and stop all monitoring or measuring.
2. Apply AC power to the monitor and allow the battery to charge uninterrupted for 10 hours.
3. Remove AC power and allow the monitor to run from the battery until it shuts off.
4. The operating time of battery reflects its performance directly.

If your monitor has two battery slots, you can check two batteries at the same time. Please replace the battery or contact with the maintenance personnel if its operating time is significantly lower than the specified time.

NOTE

- **Life expectancy of a battery depends on how frequent and how long it is used. For a properly maintained and stored lead-acid or lithium ion battery, its life expectancy is about 2 or 3 years respectively. For more aggressive use models, life expectancy can be less. We recommend replacing lead acid batteries every 2 years and lithium ion batteries every 3 years.**
- **The battery might be damaged or malfunctioned if its operating time is too short after being fully charged. The operating time depends on the configuration and operation. For example, measuring NIBP more frequently will also shorten the operating time.**

2.5.2 Battery Recycling

When a battery has visual signs of damage, or no longer holds a charge, it should be replaced. Remove the old battery from the monitor and recycle it properly. To dispose of the batteries, follow local laws for proper disposal.

⚠WARNING

- **Do not disassemble batteries, or dispose of them in fire, or cause them to short circuit. They may ignite, explode, leak or heat up, causing personal injury.**

FOR YOUR NOTES

3 Installation and Maintenance

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3.1 Installation

⚠WARNING

- **The installation of the monitor must be carried out by personnel authorized by Mindray. The software copyright of the monitor is solely owned by our company. Any action to change, copy or exchange the software copyright by any organization or person is regarded as copyright infringement and is not allowed.**

3.1.1 Unpacking and Checking

Before unpacking, examine the packing case carefully for signs of damage. If any damage is detected, contact the carrier or our company.

If the packing case is intact, open the package and remove the instrument and accessories carefully. Check all materials against the packing list and check for any mechanical damage. Contact our Customer Service Department for in case of any problem.

NOTE

- **Please save the packing case and packaging material for future transport and storage.**

⚠WARNING

- **Be sure to keep the packaging materials from children's reach.**
- **Disposal of the packaging materials shall comply with your local requirements.**
- **The equipment might be contaminated in storage, transport or when used. Verify the package and the single use accessories are intact. In case of any damage, do not apply it to patients.**

3.1.2 Environmental Requirements

The operating environment of the monitor must meet the requirements specified in the section ***A.2 Environmental Specifications*** of ***Appendix A Product Specifications***.

The environment where this monitor is to be used should be free from noise, vibration, dust, and corrosive or explosive and inflammable substances. For a cabinet mounted installation, allow sufficient room at the front and the rear of the cabinet for operation, maintenance and servicing. Besides, allow at least 2 inches clearance around the instrument for proper air circulation.

Condensation can form when the monitor is moved from one location to another, and being exposed to differences in humidity or temperature. Make sure that during operation the instrument is free from condensation.

3.1.3 Power Source Requirements

The power applied to the monitor must meet the requirements specified in the section ***A.3 Power Source Specifications*** of ***Appendix A Product Specifications***.

⚠WARNING

- **Make sure that the operating environment and the power applied to the patient monitor complies the specified requirements. Otherwise its performance might not meet the specifications claimed in *Appendix A Product Specifications*, and unexpected results, such as damages to the patient monitor, may be incurred.**
- **The monitor shall be powered according to the requirement for the system power voltage. Otherwise, serious damage might be caused to the system.**

3.1.4 Bracket Mounting

For details, please refer to the corresponding instructions for use of bracket mounting.

3.1.5 Installation Method

⚠WARNING

- **Accessory equipments connected to this patient monitor must be certified according to the respective IEC standards (e.g. IEC 60950 for information technology equipment and IEC 60601-1 for medical electrical equipment). Furthermore all configurations shall comply with the valid version of the system standard IEC 60601-1-1. Any person who connects additional equipment to the signal input or signal output is responsible to ensure the system complies with the requirements of the valid version of the system standard IEC 60601-1-1. If in doubt, contact our company or customer service.**
- **If the monitor is connected to another electrical instrument and the instrument specifications cannot tell whether the instrument combination is hazardous (e.g. due to summation of leakage currents), you should consult Mindray or experts in the field to ensure the required safety of all instruments concerned.**

NOTE

- **The following operations are not all required. User-customized installation by authorized personnel is provided.**

3.1.5.1 Connecting to AC Power Supply

1. Use the original three-wire AC power cord.
2. Connect the power cord to the receptacle for AC power cord on the rear panel of the monitor.
3. Connect the other end of the power cord to a compatible 3-prong hospital grade AC power outlet.

The 3-prong power outlet must be ground. If it is doubted, contact related personnel of the hospital.

⚠WARNING

- **Do not use three-wire to two-wire adapter with this instrument.**
- **To avoid unexpected power interruption, do no use power outlet with a wall-mounted switch control.**

3.1.5.2 Installing the Battery

If the monitor is to be powered by the internal battery, install the battery following the steps as below:

1. Slide the battery door toward the rear of the monitor to open it.
2. Move the battery catch above to one side using one finger.
3. Insert a battery into the battery slot.
4. Move the battery catch to another side, and then insert the other one in the same way, if your monitor is equipped with two batteries.
5. Release the battery catch, and it will fix the battery.
6. Close the battery door.

⚠WARNING

- **Make sure the battery door is securely latched. Falling batteries could seriously or fatally injure a patient.**

3.1.5.3 Equipotential Grounding

When other equipments are used together with the monitor, a grounding cable should be used to connect the equipotential grounding connectors of the monitor and of other equipments. This helps to reduce the potential differences between different pieces of equipment, and ensure the safety of the operator and patient.

⚠WARNING

- **If the grounding system is in doubt, the monitor must be supplied from its internal battery.**

3.1.5.4 Connecting Patient Sensors and Probes

Connect the necessary patient sensors or probes to the monitor. For details, see the chapters for specific parameter monitoring in the following pages, or corresponding instructions for sensors and probes.

3.1.5.5 Connecting the Network Cable

The network connector of the monitor is a standard RJ45 connector. It connects the monitor with the central monitoring system, or with a PC for online upgrading or data output. It can also connect with another patient monitor for viewbed monitoring.

1. Connect one end of the network cable with the network connector of the monitor.
2. Connect the other end of the network cable with the hub or switch of the central monitoring system, or with the network connector of a PC, or with the network connector of another patient monitor.

NOTE

- **Different network cable may be used for different connections. Please consult our customer service personnel for details.**
- **The system upgrading through the network connector is to be executed by Mindray authorized personnel only.**

3.1.5.6 Auxiliary Output Port

The auxiliary output port can be used to generate analog signals, nurse call signals or defibrillator synchronization signals.

- Analog output signals can be generated when the monitor is connected to an oscilloscope or a pen recorder.
- If the monitor is connected with the Nurse Call System of a hospital through a special nurse call cable, the monitor can generate nurse call signals when alarms occur.
- If the monitor is connected with a defibrillation equipment, the monitor can generate defibrillator synchronization signals to the defibrillation equipment.

To generate different signals, you must first select the AUX OUTPUT to corresponding options. For details, please refer to ***4.7 Maintenance***.

NOTE

- **For detailed connection methods of different uses, please consult the specialist in your hospital, or our Customer Service.**
- **The nurse call cable has two non-polarized conducers at the output end. The installation should be performed by Mindray servicing engineers or engineers of the hospital according to the specific nurse call system of the hospital.**

⚠WARNING

- **Before defibrillating the patient, the user should ensure the defibrillator and the monitor have been tested as a system and the two devices can work together safely and effectively.**

3.1.5.7 Connecting to VGA Monitor

This monitor can be connected with a standard color VGA monitor. The VGA monitor will display the patient waveforms and parameters measured by the patient monitor. To connect the patient monitor with the VGA monitor, follow the steps as below.

1. Power off the patient monitor.
2. Connect the signal cable of the VGA monitor to the VGA connector on the rear panel of the patient monitor.
3. Power on the VGA monitor and then the patient monitor.

NOTE

- **The VGA monitor should be installed at a distance of more than 1.5 m from the patient.**

3.1.6 Powering on the Monitor

After installing the monitor, please follow the procedures described below to power on the monitor:

1. Before using the monitor, please carry out corresponding safety inspection as given in ***3.2.1 Inspection***.
2. Press the Power Switch on the control panel. A beep will be heard and, at the same time, the alarm indicator will flash once in yellow and then red.
3. The system begins self-testing and the product model will be displayed on the screen.
4. Several seconds later, the system finishes the self-test and displays the main screen.
5. The system will initiate every module, and display "XX alarm disabled!" information in the lower left part of the screen. "XX" represents the name of every module, such as NIBP, RESP etc.
6. At this time, you can operate the monitor using the control panel. "XX alarm disabled!" information will disappear a few seconds later.

When the monitor is plugged into AC power and is turned OFF or not turn ON, the monitor only provides the function of battery charging.

NOTE

- **During initialization process, alarms of every module detected by the system are useless, and thereby are disabled.**

3.1.7 Powering off the Monitor

To power off the monitor, please follow the procedures below:

1. Confirm the patient monitoring is to be finished.
2. Disconnect the cables and sensors between the monitor and the patient.
3. Confirm whether to store or clear the patient monitoring data.
4. Press the Power switch for more than 2 seconds, and the monitor will be powered off.

3.2 Maintenance

⚠WARNING

- **Failure on the part of the responsible hospital or institution employing the use of the monitoring equipment to implement a satisfactory maintenance schedule may cause undue equipment failure and possible health hazard.**
- **The safety inspection or maintenance, which requires opening the monitor housing, must be performed by trained and authorize personnel only. Otherwise, equipment failure and possible health hazard may be caused.**

3.2.1 Inspection

Make sure the qualified service personnel have implemented a complete inspection before putting the monitor into operation, after monitor servicing or system upgrading, or after the monitor has been used for 6-12 consecutive months. This is to ensure the normal operation of the system.

Follow these guidelines when inspecting the equipment:

- The environment and the power supply meet the specified requirements.
- Inspect the keys, control knob, connectors and accessories for damage.
- Inspect the power cords for fraying or other damage and check the insulation.
- The grounding cables are correctly connected.
- Only specified accessories like electrodes, sensors and probes are applied.
- The monitor clock is correct.
- The audible and visual alarms functions normally.
- The recorder functions normally and the recorder paper meets the requirement.

The defibrillator synchronization function must be verified according to your hospital regulations, and be checked by a qualified technician once every 3 months.

In case of any damage or exception, do not use the monitor. Contact the technician in your hospital or our Customer Service immediately.

3.2.2 Cleaning

⚠WARNING

- **Be sure to shut down the system and disconnect all power cords from the outlet before cleaning the equipment.**

Your equipment should be cleaned on a regular basis. If there is heavy pollution or lots of dust and sand in your place, the equipment should be cleaned more frequently. Before cleaning the equipment, consult your hospital's regulations for cleaning and disinfecting equipment.

The exterior surfaces of the equipment may be cleaned with a clean and soft cloth, sponge or cotton ball, dampened with a non-erosive cleaning solution. Drying off excess cleaning solution before cleaning the equipment is recommended. Following are examples of cleaning solutions:

- Diluted soap water
- Diluted ammonia water
- Diluted sodium hyoichlo (bleaching agent)
- Diluted formaldehyde (35 to 37%)
- Hydrogen peroxide (3%)
- Ethanol (70%), or Isopropanol (70%)

To avoid damage to the equipment, follow these rules:

- ALWAYS dilute the solutions according to the manufacturer's suggestions.
- ALWAYS wipe off all the cleaning solution with a dry cloth after cleaning.
- NEVER submerge the equipment into water or any cleaning solution, or pour or spray water or any cleaning solution on the equipment.
- NEVER permit fluids run into the casing, switches, connectors, or any ventilation openings in the equipment.
- NEVER use abrasive, erosive cleaners, or cleaners containing acetone.

Failure to follow these rules may erode or fray the casing, or blur lettering on the labels, or cause equipment failures.

For cleaning information of accessories, please refer to the chapters for specific patient parameters and the instructions for use of the accessories.

3.2.3 Disinfection

Disinfection may cause damage to the equipment. We recommend the disinfection is contained in the hospital's servicing schedule only when necessary. The equipment should be cleaned prior to disinfection.

Recommended disinfection material: Alcohol based (Ethanol 70%, Isopropanol 70%), and aldehyde based.

⚠WARNING

- **Disinfection may cause damage to the equipment; therefore, when preparing to disinfect the equipment, consult your hospital's infection controllers or professionals.**
- **The cleaning solutions above can only be used for general cleaning. If you use them to control infections, we shall assume no responsible for the effectiveness.**

NOTE

- **ALWAYS dilute the solutions according to the manufacturer's suggestions and adopt lower concentration if possible.**
- **NEVER submerge the equipment into water or any solution, or pour water or any solution on the equipment;**
- **ALWAYS wipe off all the excess liquids on the equipment surface and accessory surface with a dry cloth;**
- **Never use EtO and formaldehyde to disinfect.**
- **Never permit high-pressure and high-temperature disinfection of the equipment and accessories.**

FOR YOUR NOTES

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4.1 Overview

To open a menu, perform any of the following four operations:

1. Press the MENU key on the control panel. The SYSTEM MENU appears.
2. Select the STANDBY label on the main screen. The CONFIRM TO STANDBY menu appears.
3. Select a parameter label in a parameter window. A parameter setup menu appears. E.g. Select the ECG label to open the ECG SETUP menu.
4. Press the FREEZE key on the control panel. The FROZEN menu appears.

You can set the settings of the monitor by opening the menus above. Most settings could be saved after the monitor is turned off. Few settings, which could not be saved, will be specified in the relevant sections.

This chapter only gives introduction to the system menu. Other menus will be described in the following chapters. Press the MENU key on the control panel. The SYSTEM MENU appears as shown below.



Figure 4-1 System Menu

Most menus displayed by the monitor share the same structure. As shown above, a menu is made up of four parts:

1. Menu title: Summarizes the content of the current menu.
2. Main display area: Displays options, keys or prompt information, etc. “>>” means a submenu will pop up if the option is selected.
3. Online help: The help information changes with the highlighted selection.

4. Exit key: Exits from the current menu.

Some menus do not have the EXIT key. Instead, a YES and a NO key or a CONFIRM and a CANCEL key are provided. You can confirm the operations with these keys.

The following introduces the submenus of the SYSTEM MENU.

- PATIENT SETUP>>
- DEFAULT>>
- SYSTEM SETUP>>
- SELECTION>>
- VERSION>>
- MAINTAIN>>
- DEMO>>

Details about the TREND GRAPH>>, TREND TABLE>>, NIBP RECALL>> and ALARM RECALL>> are given in ***9 Recall***. While the DRUG CALC is detailed in ***10 Drug Calculation***.

4.2 Patient Setup

Select PATIENT SETUP>> in SYSTEM MENU. The following menu appears.

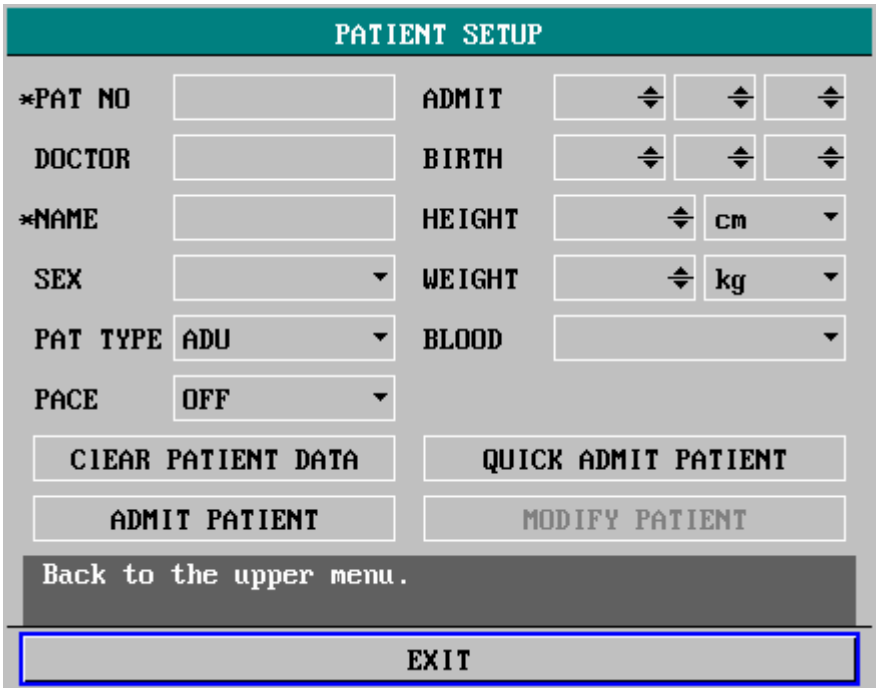


Figure 4-2 Patient Setup Menu

This menu displays the patient's information, as well as four buttons located below. If no patient is admitted, only the default settings of PAT TYPE and PACE are displayed. The DISCHARGE PATIENT and MODIFY PATIENT buttons are disabled.

If a patient is admitted, the DISCHARGE PATIENT button turns to be DISCHARGE PATIENT.

4.2.1 Admit Patient

To admit a new patient, please follow this procedure:

1. Select ADMIT PATIENT in PATIENT SETUP menu.
2. Select YES in the pop-up CONFIRM TO CLEAR THE DATA menu. The menu as shown below appears.

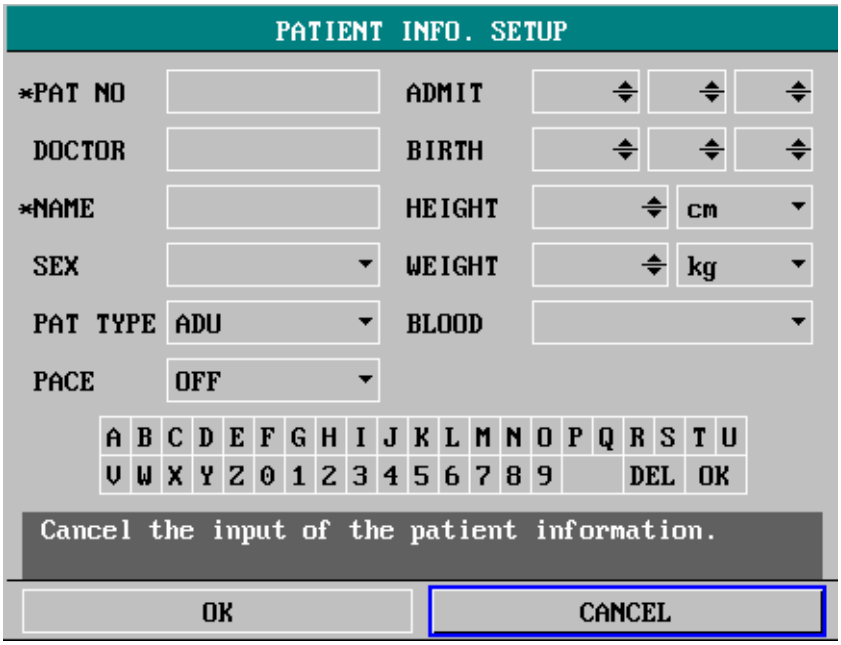


Figure 4-3 Patient Information Setup

3. Enter the patient's information details. If the patient's information is entered incompletely, corresponding symbols will appear in the upper left hand of the monitor screen.

- PAT NO — Patient identification number;
- DOCTOR — Name of the doctor;
- NAME — Patient name;
- SEX — Patient gender: "F" for female; "M" for male;
- PAT TYPE — Patient type:
  ADU, PED and NEO (short for adult, pediatric and neonate);
- PACE — Turn ON or OFF the pace analysis function;
- ADMIT — The time when the patient is admitted: year-month-day;

- BIRTH Patient date of birth: year-month-day;
- HEIGHT Patient height (unit: cm or inch);
- WEIGHT Patient weight (unit: kg or IB);
- BLOOD Patient blood type:
  A, B, O, AB or N (N represents unknown)

NOTE

- **If the PAT NO or NAME has not been input, "PATI. INFO. IMCMP" will be displayed in the patient information area.**

4. Select OK button, and the patient is admitted.
5. If the monitor is connected with the central monitoring system, you can monitor the patient through the central monitoring system.

Setting Patient Information

To enter information in a field containing no mark, follow this procedure (take DEPT. as an example):

1. Rotate the control knob and highlight the field after DEPT.
2. Press the control knob, and the cursor jumps to the soft keypad below.
3. Rotate the control knob and move the cursor to the desired letter, number or space, and press the control knob to enter the character. Select DEL button to delete the unwanted entered character.
4. Repeat step 3 until you finish the information entering.
5. Select OK on the soft keypad. The information setting finishes.

To enter information in a field containing the mark "▼", follow this procedure (take SEX as an example):

1. Rotate the control knob and highlight the field after SEX.
2. Press the control knob. A pop-up menu opens.
3. Rotate the control knob and select the desired option.

To set a feild containing the mark "⇕", follow this procedure (take BED NO as an example):

1. Rotate the control knob and highlight the field after BED NO.

2. Press the control knob.
3. Rotate the control knob and select the desired bed number. The bed number increases or decreases by one as the control knob rotates.

4.2.2 Quick Admit Patient

1. Select QUICK ADMIT PATIENT in PATIENT SETUP menu.
2. Select YES in the pop-up CONFIRM TO CLEAR THE DATA menu.
3. The menu as shown in Figure 4-4 appears. You can set the PAT TYPE and status of PACE.

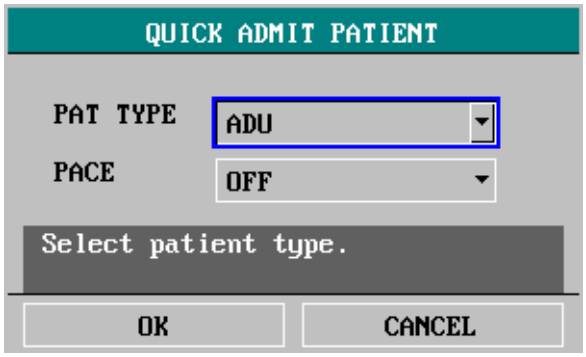


Figure 4-4 Quick Admit Patient

4. Select OK button, and the patient is admitted.
5. If the monitor is connected with the central monitoring system, you can monitor the patient throuth the central monitoring system.

4.2.3 Modify Patient

To modify the information of the patient being monitored, please follow this procedure:

1. Select MODIFY PATIENT button in PATIENT SETUP menu.
2. The menu as shown in Figure 4-3 opens.
3. Modify the patient's information as described above, and select OK button.
4. Prompt information will be displayed on the central monitoring system if the monitor is connected with it.

4.2.4 Clear Patient Data

If no patient is admitted, data stored in the patient monitor should be cleared.

1. Click the CLEAR PATIENT DATA button in the PATIENT SETUP menu.
2. Select YES in the pop-up menu.

4.2.5 Discharge Patient

If a patient has been admitted, the patient should be discharged.
To discharge the patient being monitored, please follow this procedure:

1. Select DISCHARGE PATIENT button in PATIENT SETUP menu.
2. Select YES in the pop-up menu.
3. Prompt information will be displayed on the central monitoring system if the monitor is connected with it.

4.3 Default Setup

Select DEFAULT>> in SYSTEM MENU. The following menu appears.

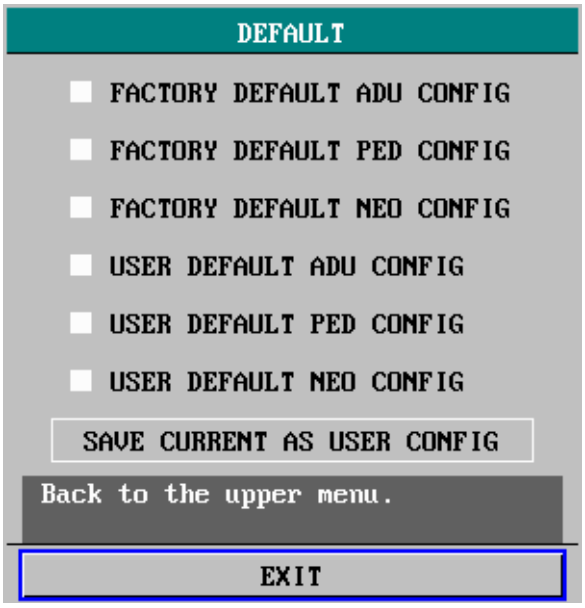


Figure 4-5 Default Setup

Restoring Factory Default Configuration

1. Rotate the control knob and select the desired configuration.
2. Select EXIT, and a CONFIRM DEFAULT CONFIG dialog box pops up.
3. Select YES to restore the monitor to the selected default configuration, or select NO to cancel the operation.

Saving Current Configuration as User Default Configuration

You can also modify the configuration of the monitor and save the modified configuration as the user-defined default configuration of the corresponding patient type. When the monitor begins monitoring a new patient, you may to choose the user-defined default configuration directly, loosing from performing the settings again. However, the user-defined configuration must be appropriate and correct.

1. Verify the modified configuration is appropriate and correct.
2. Select the SAVE CURRENT AS USER CONFIG option.
3. Select YES in the popup dialog box to save current configuration as the user-defined default configuration.
4. Select NO to cancel the operation.

4.4 System Setup

Select SYSTEM SETUP>> in SYSTEM MENU. The following menu appears.

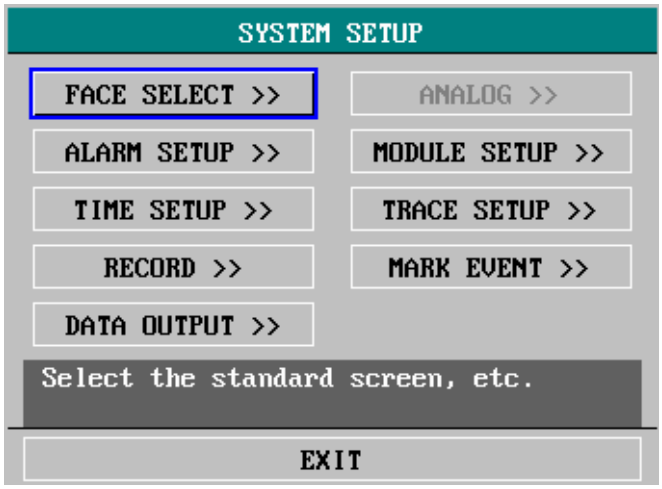


Figure 4-6 System Setup

SYSTEM SETUP menu contains the following submenus:

- FACE SELECT>>
- ALARM SETUP>>
- TIME SETUP>>
- RECORD>>
- DATA OUTPUT>>
- ANALOG>>
- MODULE SETUP>>
- TRACE SETUP>>
- MARK EVENT>>

4.4.1 Face Select

Select FACE SELECT>> in SYSTEM SETUP menu. The following menu appears.

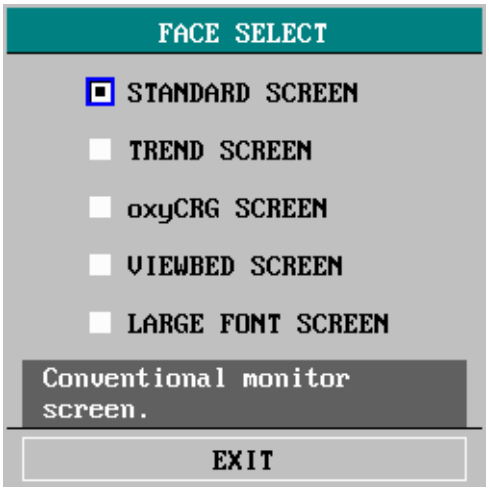


Figure 4-7 Face Select

In the FACE SELECT menu, options are available as shown above. For detailed information, see ***5 Face Selection***.

4.4.2 Alarm Setup

Select ALARM SETUP>> in SYSTEM SETUP menu. The following menu appears.

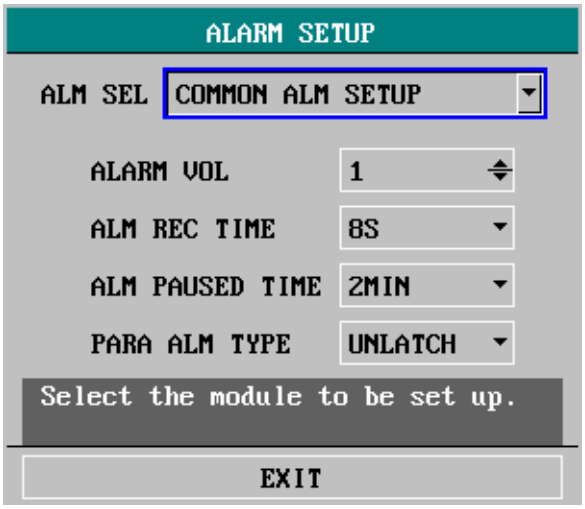


Figure 4-8 Alarm Setup

You can perform the following settings in the menu above:

- ALM SEL — Alarm selection
  Options: COMMON ALM SETUP, XX ALM SETUP; (XX refers to HR, ST, PVCs, SPO2, NIBP, IBP (1,2), CO2, RESP, TEMP, CO and AG).
- ALARM VOL — Alarm volume
  The volume can be set between 0 and 10. 0 means off and 10 is the maximum volume.
- ALM REC TIME — Alarm recording time
  Options: 8S,16S and 32S.
  When an alarm occurs, the recorder records according to the alarm recording time.
- ALM PAUSED TIME — Options: 1MIN, 2MIN and 3MIN.
- PARA ALAM TYPE — Options : LATCH and UNLATCH.

Detailed information about alarms is given in chapter ***6 Alarms***.

If a parameter alarm setup is selected from the drop-down list of ALM SEL, the corresponding alarm setup items will be displayed in the ALARM SETUP menu.

When the ALARM VOL is set to 0, data will not be saved upon power failure. After the monitor restarts, the ALARM VOL restores the default.

When the ALARM VOL is set to 0, it will restore its default if you silence or pause alarms.

4.4.3 Time Setup

Select TIME SETUP>> in SYSTEM SETUP menu. The following menu appears.



Figure 4-9 Time Setup

With the control knob, you can change the year, month, day, hour, minute and second as well as select the displayed format of the time. YYYY, MM, and DD refer to year, month and day respectively.

If the monitor is connected with the central monitoring system, the system time of the monitor will be updated in accordance with the central monitoring system, and the TIME SETUP option in SYSTEM SETUP menu will become disabled.

4.4.4 Recorder Setup

Select RECORD>> in SYSTEM SETUP menu. The following menu appears.



Figure 4-10 Recorder Setup

- REC WAVE1 Recorded waveform1
  Options: ECG1, ECG2, SPO2, IBP1, IBP2, CO2, RESP, N2O, O2, AA and OFF.

In MULTI-LEADS DISPLAY mode or HALF-SCREEN MULTI-LEADS display mode, the ECG3, ECG4, ECG5 and ECG6 options are also available. When OFF is selected, waveform 1 will not be recorded.

- REC WAVE2 Recorded waveform 2

Recorded waveform 2 has the same options as waveform 1, but the selected waveform 2 cannot be identical to waveform 1. Otherwise, the system will automatically change one of the waveforms to a different parameter.

NOTE

- **If a parameter is not displayed on the screen, this parameter will be unavailable in the REC WAVE 1 and the REC WAVE 2 options.**

- RT REC TIME — Real-time recording time
  Options: CONTINUAL and 8s.
- TIMING REC TIME — Timing recording time
  The interval between automatic recordings.
  Options: OFF, 10MIN, 20MIN, 30MIN, 40MIN, 50MIN, 1HOUR, 2HOURS, 3HOURS and 4HOURS. The monitor will start recording at the selected interval, record for 8s and stop automatically.

NOTE

- **TIMING REC TIME cannot be saved after the monitor is turned off. But it can be saved as the user default configuration.**
- **RT REC TIME has priority over TIMING REC TIME.**

- REC RATE — Recording rate
  Options: 25.0 and 50.0; unit: mm/s;
- REC GRID — Recording grid
  ON: You can select ON to print a grid on the recorder paper;
  OFF: You can select OFF to print without grid on the recorder paper.
- CLEAR REC TASK — Clear recording task
  This key allows you to clear all current recording tasks.

For details about recording operations, see chapter ***8 Recording***.

4.4.5 Data Output

Select DATA OUTPUT>> in SYSTEM SETUP menu. The following menu appears.

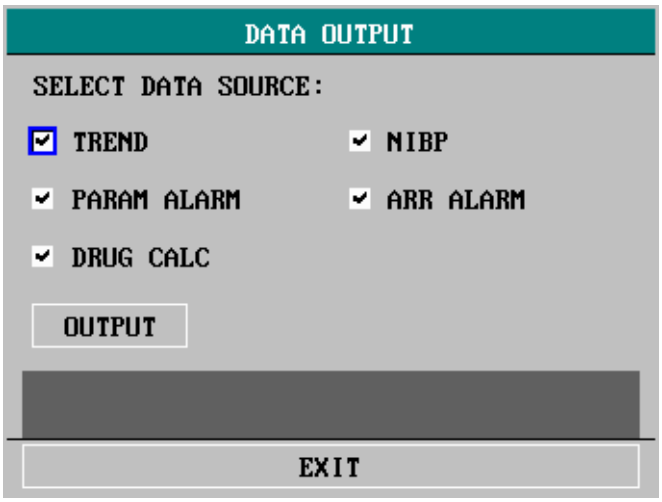


Figure 4-11 Data Output

Output Procedure

1. Disconnect all patient cables connected to the monitor.
2. Verify the monitor is connected to the PC and the PC is running the Patient Information Recall System software.
3. Select from the five data source options: TREND, PARAM ALARM (parameter alarm), DRUG CALC (drug calculation), NIBP and ARR ALARM (arrhythmia alarm).
4. Select OUTPUT in the menu and the prompt ”CONNECTING…” is shown aside. If you exit the DATA OUTPUT menu at this time, the prompt will be displayed in prompt information area at the lower left corner of the screen.
5. If the connection is available, the data will be output to the PC. For more information, please refer to the help information of the Patient Information Recall System software.

NOTE

- **If no data source is selected or the previous data output has not finished, the OUTPUT option in the DATA OUTPUT menu will be inactive.**
- **During data output, the NEW PATIENT option in the PATIENT SETUP menu is inactive.**

4.4.6 Analog Output

Select ANALOG >> in SYSTEM SETUP menu. The following menu appears.

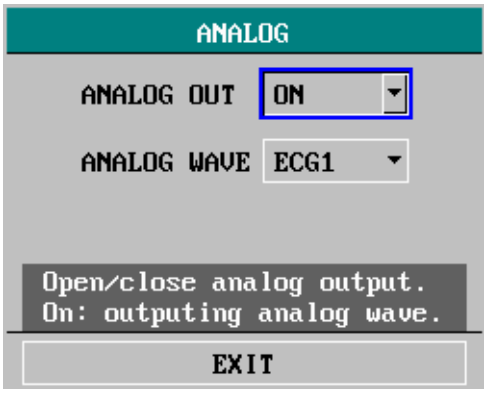


Figure 4-12 Analog Output

You can perform the following settings in the menu above:

- ANALOG OUT — Analog output
  Options: ON and OFF.
  When ON is selected, analog signals can be output from the auxiliary output port on the rear panel of the monitor.
- ANALOG WAVE — Options: ECG1, ECG2, IBP1 and IBP2;
  In the MULTI-LEADS DISPLAY mode, the ECG3, ECG4, ECG5 and ECG6 options are also available.

NOTE

- **If DEFIB. SYN or NURSE CALL is selected from the AUX OUTPTU options in the USER MAINTAIN menu, the ANALOG>> option in the SYSTEM SETUP menu will be inactive, and the monitor will be unable to output analog signals. For details, please refer to *4.7 Maintenance*.**

4.4.7 Module Setup

Select MODULE SETUP>> in SYSTEM SETUP menu. The following menu appears.

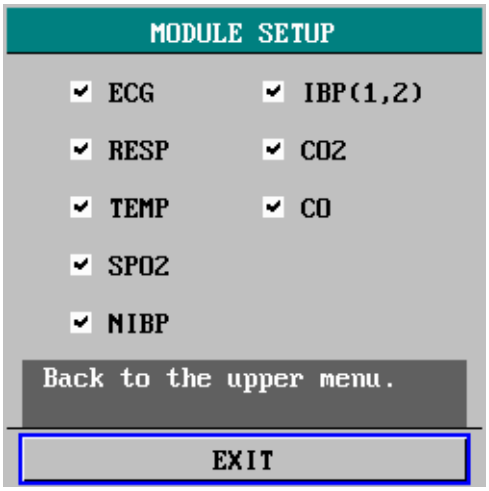


Figure 4-13 Module Setup

This menu allows you to enable or disable a parameter module to determine the information displayed on the main screen. As shown in the figure above, " √ " indicates an enabled module. A module without the " √ " mark is disabled and the related waveform and parameter data disappear from the display.

4.4.8 Trace Setup

Select TRACE SETUP>> in SYSTEM SETUP menu. The following menu appears.

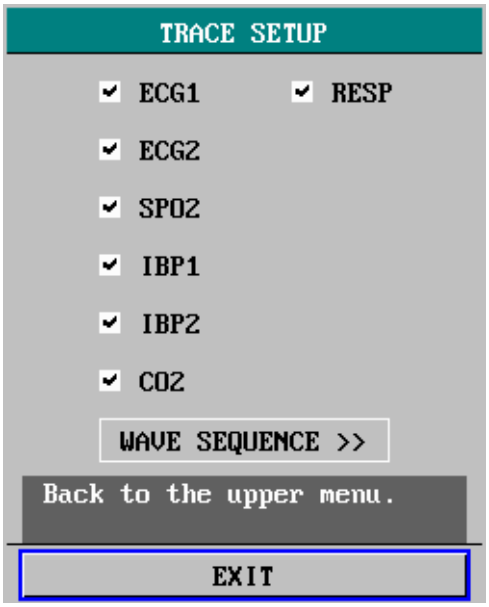


Figure 4-14 Trace Setup

This menu allows you to select the parameter waveform(s) to be displayed. The mark " √ " indicates the parameter waveform will be displayed, and that without the mark will not be displayed. The TRACE SETUP menu merely contains the parameter modules enabled in the MODULE SETUP menu. Besides, in the MULTI-LEADS DISPLAY mode or the HALF-SCREEN MULTI-LEADS display mode, the ECG1 waveform and the ECG2 waveform are inactive.

In addition, the WAVE SEQUENCE >> option allows you choose in which sequence the parameter waveforms are displayed from the upper to the lower.

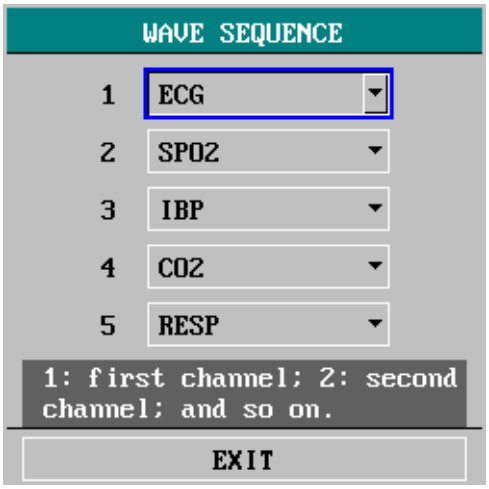


Figure 4-15 Wave Sequence

4.4.9 Mark Event

Select MARK EVENT>> in SYSTEM SETUP menu. The following menu appears.

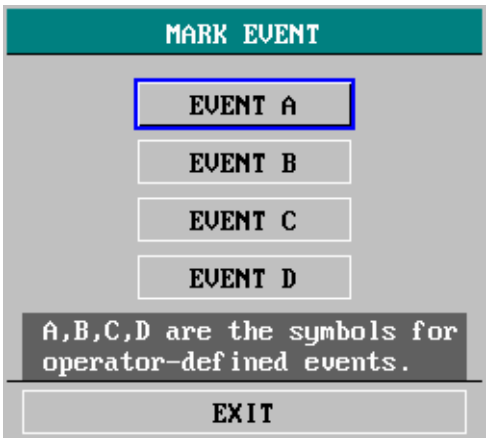


Figure 4-16 Mark Event

This menu allows you to mark four different events, namely event A, B, C and D. The ”@” symbol will appear in the frame of the even being selected. If you attempt to unmark an event, press the control knob again on the marked selection.

The purpose of event marking is to define the records, such as dose taking, injections or therapy, which have influence on patients and parameter monitoring. A mark will be displayed on the trend graph/table indicating the time the mark was initiated in relation to the event it represents.

4.5 Selection Setup

Select SELECTION>> in SYSTEM MENU. The following menu appears.



Figure 4-17 Selection Setup

You can perform the following settings in this menu:

- KEY VOL — Key volume
  The volume can be set between 0 and 10. 0 indicates the volume is off and 10 indicates the maximum volume.
- HELP — Online help
  ON: Indicates the online help is enabled and the help information will be displayed;
  OFF: Indicates the online help function is disabled and the help information will not be displayed.
- SCAN TYPE — Scan type
  REFRESH: The waveform keeps stationary, with real-time refreshing from the left to the right by a moving "erase bar";
  SCROLL: The waveform moves from the right to the left with time passing by.
- ALM LIMIT — Alarm limit
  ON: The alarm limits of parameters are displayed aside the parameter value;
  OFF: The alarm limits of parameters are not displayed aside.
- BRIGHTNESS — The brightness can be set between 1 and 10. 1 indicates the lowest brightness and 10 indicates the highest brightness.

4.6 Monitor Version

Select VERSION>> in SYSTEM MENU. The following menu appears.


VERSION
Version 02.00.00 Sep 27 2005
Copyright(c) Mindray Co., Ltd.
DEVICE CONFIG LIST >>
DEVICE VERSION LIST >>
Enter the menu containing the list of device functions.
EXIT

Figure 4-18 Version

You can see the software versions of the monitor. The DEVICE CONFIG LIST>> option allows you to see the configuration of the monitor.

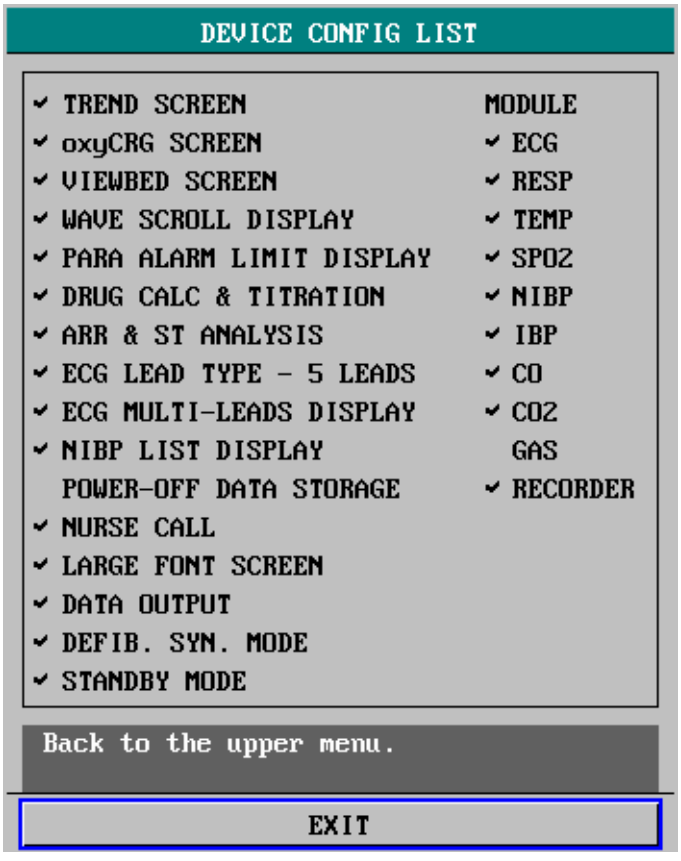


Figure 4-19 Device Configuration List

The DEVICE VERSION LIST>> option allows you to see the following version information.

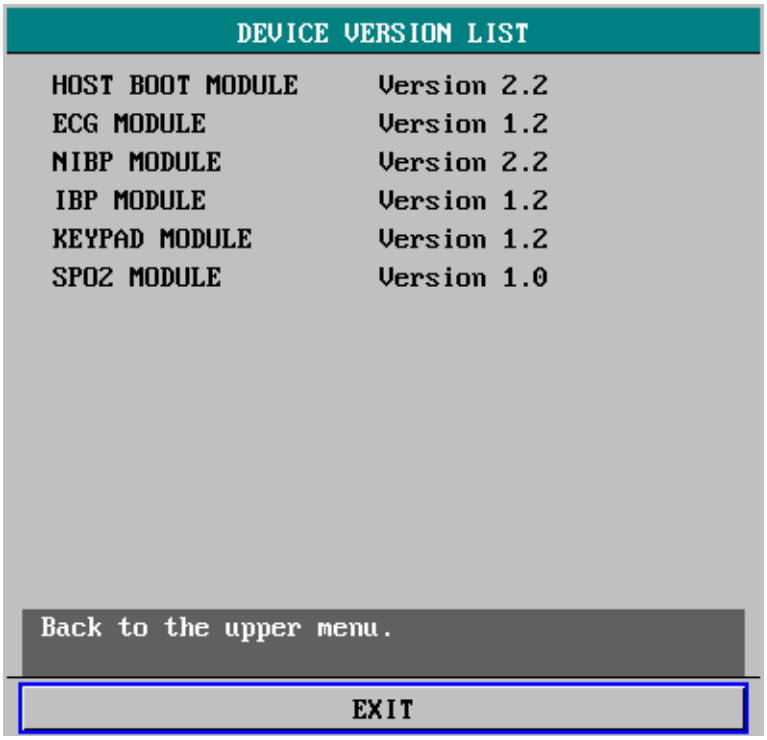


Figure 4-20 Device Version List

4.7 Maintenance

Select MAINTAIN>> in SYSTEM MENU. The following menu appears.

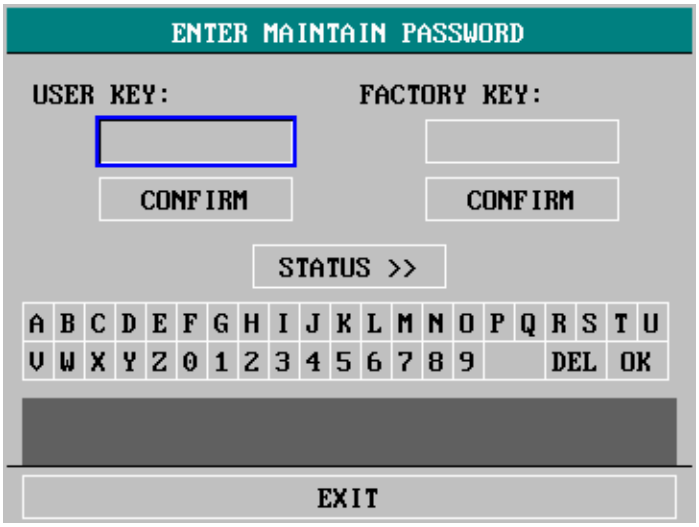

ENTER MAINTAIN PASSWORD
USER KEY:
FACTORY KEY:
CONFIRM
CONFIRM
STATUS >>
A B C D E F G H I J K L M N O P Q R S T U
V W X Y Z 0 1 2 3 4 5 6 7 8 9 DEL OK
EXIT

Figure 4-21 Enter Maintain Password

Enter USER KEY, then select CONFIRM button. The following menu appears.

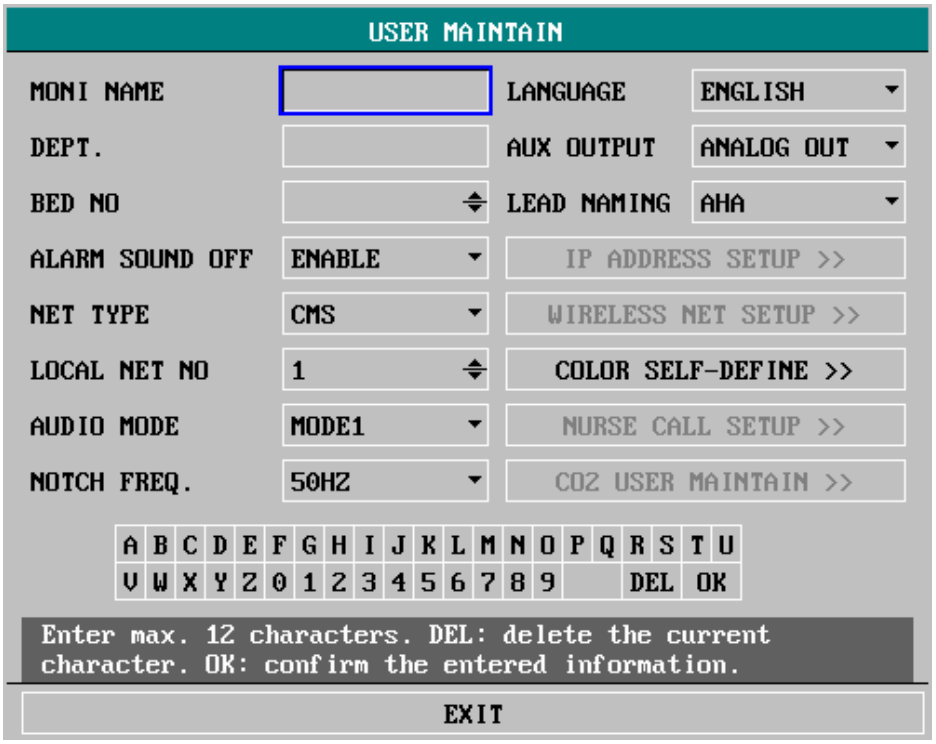


Figure 4-22 User Maintain

You can perform the following settings:

- MONI NAME — Monitor's name.
- DEPT. — The department where the monitor is located.
- BED NO — The bed number where the monitor is located.
- ALARM SOUND OFF — ENABLE: the alarm volume can be set to 0;
  DISABLE: the alarm volume cannot be set to 0..

The audible alarms will be turned ON when the monitor is restarted.

- NET TYPE — Network type
  Options: CMS and CMS+.
- LOCAL NET NO — It indicates the bed number of a monitor in the monitoring network. If the NET TYPE is CMS, the LOCAL NET NO can be set between 1 and 64; if the NET TYPE is CMS+, it can't be set.
- AUDIO MODE — Audible alarm mode
  Mode1: The monitor sounds at an interval of 8s when a high priority alarm occurs, and at an interval of 24s when a medium priority alarm occurs. The lead-off alarm is of the low priority level.
  Mode 2: The monitor sounds at an interval of 3s when a high priority alarm occurs, and at an interval of 14s when a medium priority alarm occurs. The lead-off alarm is of the medium priority level.
- LINE FREQ. — Line frequency
  Options: 50Hz and 60Hz;
  If NOTCH is turned ON, the monitor filters the ECG signals with the selected line frequency.
- LANGUAGE — Select the required language of the displayed texts.
- AUX OUTPUT — Three options are available:

1. ANALOG OUT (analog output)

- If this option is selected, the auxiliary output port will be able to output analog signals, and you can perform the settings in the ANALOG menu. For details, see ***4.4.6 Analog Output***.
- If this option is not selected, the analog output function will be disabled and the ANALOG >> option in the SYSTEM SETUP menu will become inactive. In this situation, you cannot set the information in the ANALOG menu.

2. NURSE CALL

- If this option is selected, the auxiliary output port will be able to output nurse call signals, and you can perform the settings in the NURSE CALL SETUP submenu of the USER MAINTAIN menu. For details, see ***4.7.4 Nurse Call Setup***.
- If not selected, the nurse call function will be disabled and the NURSE CALL SETUP>> option in USER MAINTAIN will become inactive. In this situation, you cannot set the information in the NURSE CALL SETUP submenu.

3. DEFIB. SYN (defibrillator synchronization signals)

- If this option is selected, the auxiliary output port will be able to output defibrillator synchronization signals. In this situation, you can turn on DEFIB SYNC in the ECG SETUP menu to enable the defibrillator synchronization. For details, see ***11.3 ECG Setup Menu***.
- If not selected, the defibrillator synchronization function will be disabled and the DEFIB SHNC option in the ECG SETUP menu will set to OFF (it will not be user-adjustable).

- LEAD NAMING — Options: AHA and EURO; For details, see ***11.2.2 Electrode Placement***.

⚠WARNING

- **Please be cautious when you use the ALARM SOUND OFF function.**

NOTE

- **If you set ALARM SOUND OFF to ENABLE when the ALARM VOL is 0, the ALARM VOL will restore the default.**
- **The setting of the line frequency can neither be saved as the default user configuration nor changed when the default factory configuration is selected. Once set by a user, no operation except for manual adjustment can change it. The setting keeps the same even when the monitor is restarted.**

4.7.1 IP Address Setup

When the monitor is connected with the central monitoring system, and the NET TYPE is CMS+, you need to set the IP address of your monitor. Select IP ADDRESS SETUP in USER MAINTAIN menu. The following menu appears. For details, please contact with the technician responsible for the central monitoring system in your hospital.

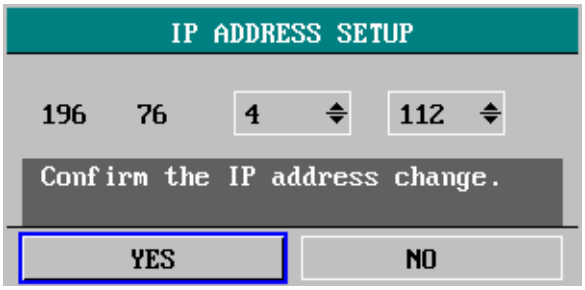


Figure 4-23 IP Address Setup

4.7.2 Wireless Net Setup

This monitor can be configured with wireless network, which is connected to the CMS (Central Monitoring System) in the wireless mode and constructs with the CMS the monitoring network.

Note

- **If the monitor is connected through the network connector, the use of this connection is preferentialer than the wireless network.**
- **If the wireless network is configured, there will be a mark " √ " in front of "Wireless Net" in the DEVICE CONFIG LIST menu (See *4.6* Monitor Version).**

Select WIRELESS NET SETUP in USER MAINTAIN MENU. The following menu appears. If the monitor connects with the central monitoring system through a compact flash adapter, the ESS ID and CHANNEL NUMBER must be correctly set. For details, please contact with the technician responsible for the central monitoring system in your hospital.


WIRELESS NET SETUP
ESS ID
CMS
CHANNEL NUMBER
6
A B C D E F G H I J K L M N O P Q R S T U
V W X Y Z 0 1 2 3 4 5 6 7 8 9
DEL
OK
Back to the upper menu.
EXIT

Figure 4-24 Wireless Net Setup

4.7.3 Self Definition of Color

Select COLOR SELF-DEFINE >> in USER MAINTAIN menu. The following menu appears.



Figure 4-25 Self-definition of color

This menu allows you to choose in which color the waveform(s) and parameter(s) of a parameter module are to be displayed.

- OTHER PARA refers to the parameters, NIBP and TEMP, which do not have waveform.
- CO2 refers to the parameters measured by CO_2 module or AG module.
- AG O2, AG N2O and AG AA refer to corresponding parameters measured by AG module.
- AA refers to the used anesthetic agent. If the anesthetic agent is available before opening the COLOR SELF-DEFINE menu, the name of the anesthetic agent will be displayed instead of AA.

4.7.4 Nurse Call Setup

Select NURSE CALL SETUP >> in USER MAINTAIN menu. The following menu appears.

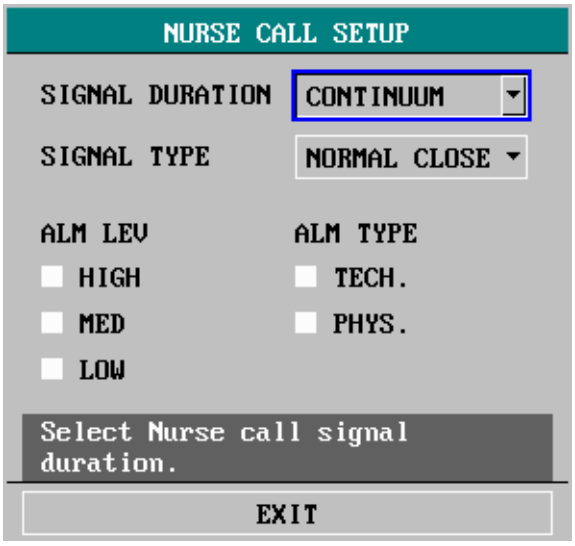


Figure 4-26 Nurse Call Setup

You can perform the following settings:

■ SIGNAL DURATION

Two options are available: PULSE, and CONTINUUM.

1. PULSE

When pulse is selected, a nurse call signal is a pulse signal lasting 1s. When multiple alarms occur simultaneously, only one pulse signal will be output. If an alarm comes out before the previous alarm is cleared, another pulse signal will be output.

2. CONTINUUM

When continuum is selected, the duration of a nurse call signal is the same with the alarm, namely, from the time that the alarm occurs to the time it disappears.

■ SIGNAL TYPE

1. NORMAL OPEN: Select this option when the hospital's call system is set to NORMAL OPEN.
2. NORMAL CLOSE: Select this option when the hospital's call system is set to NORMAL CLOSE.

- ALM LEV Alarm level
  Options: HIGH, MED (medium) and LOW.
  More than one option can be selected at one time.
- ALM TYPE Alarm type
  Options: TECH. (technical) and PHYS. (physiological).
  Both options can be selected at one time.

Trigger Conditions

A nurse call signal will be triggered only if all the following conditions are met:

1. The nurse call function is enabled.
2. An alarm of the preset alarm level and alarm type comes out.
3. The monitor is not in the Alarms Paused or the System Silenced status.

NOTE

- **If no option in ALM LEV or ALM TYPE is selected, the nurse call signal will not be triggered in whatever condition.**
- **The nurse call function can't be used as the main alarm notice method. Medical staff must combine the audible and visual alarms, the clinical vital signs of the patient to determine the patient's situation.**
- **In the Alarms Paused or the System Silenced status, the nurse call function of the monitor will be disabled automatically.**

4.7.5 CO_2 User Maintain

Selecting CO2 USER MAINTAIN >> in USER MAINTAIN menu opens the CO2 USER MAINTAIN menu. The options contained in this menu are relative with the CO_2 module that you monitor is equipped with. For details, please refer to ***17.2.4 CO2 User Maintain Menu*** and ***17.3.4 CO2 User Maintain Menu***.

4.7.6 Monitor Status

Select STATUS >> in ENTER MAINTAIN PASSWORD menu. The following menu appears.

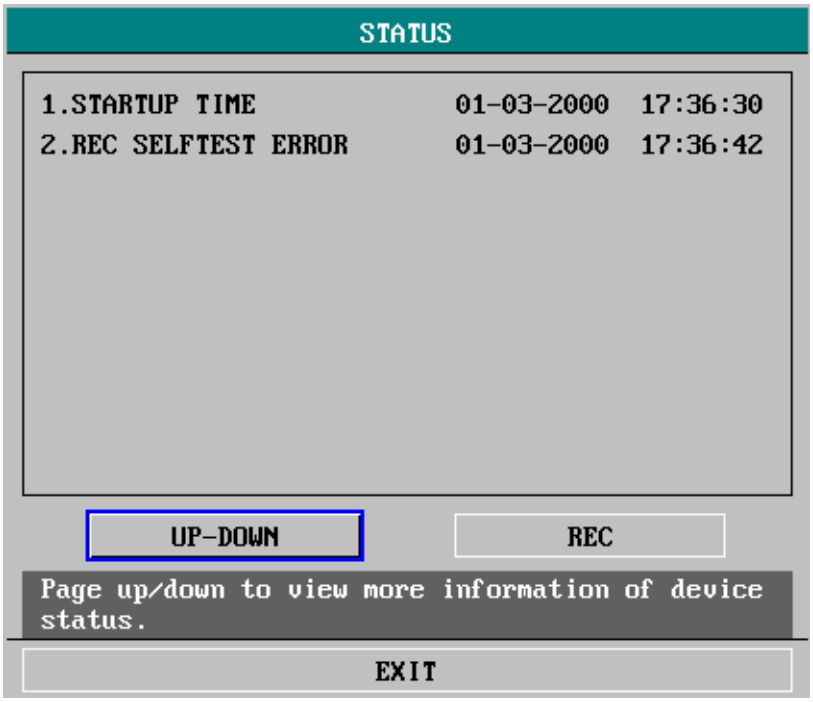


Figure 4-27 Monitor Status

- UP-DOWN — This menu can display a maximum of ten status messages. In case of more than ten, you can select UP-DOWN to learn other status messages.
- REC — Recording
  You can select the REC option to record the status message displayed.

4.8 DEMO Function

Select DEMO >> in SYSTEM MENU. The following menu appears.

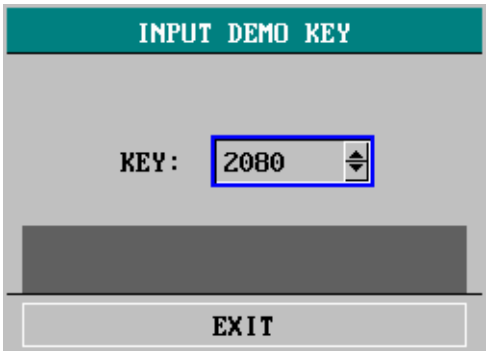


Figure 4-28 Input Demo Key

The monitor enters the demonstration mode when the correct password is input in the menu above. The word DEMO will be displayed on the main screen. The purpose of the demonstration display is to demonstrate the performance of the monitor, and for training purposes.

⚠WARNING

- **In clinical applications, this function is forbidden because the DEMO display can mislead the medical staff to treat the DEMO waveforms and parameters as the actual data of the patient. This may result in serious injury to the patient, or a delay of treatment or improper treatment.**

5 Face Selection

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5.1 Standard Screen

As described in ***4.4.1 Face Select***, you can open the FACE SELECT menu by selecting FACE SELECT >> in SYSTEM SETUP menu.

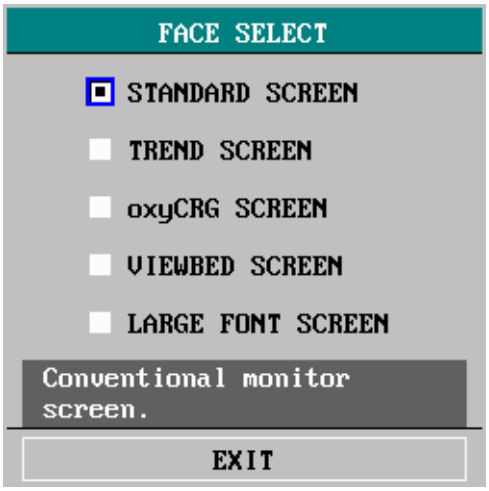


Figure 5-1 Face Select

The standard screen is the default screen. If the current screen is not the standard screen, you may enter the standard screen by selecting STANDARD SCREEN and then selecting EXIT in FACE SELECT menu. For more information about the standard screen, see ***2.4 Display***.

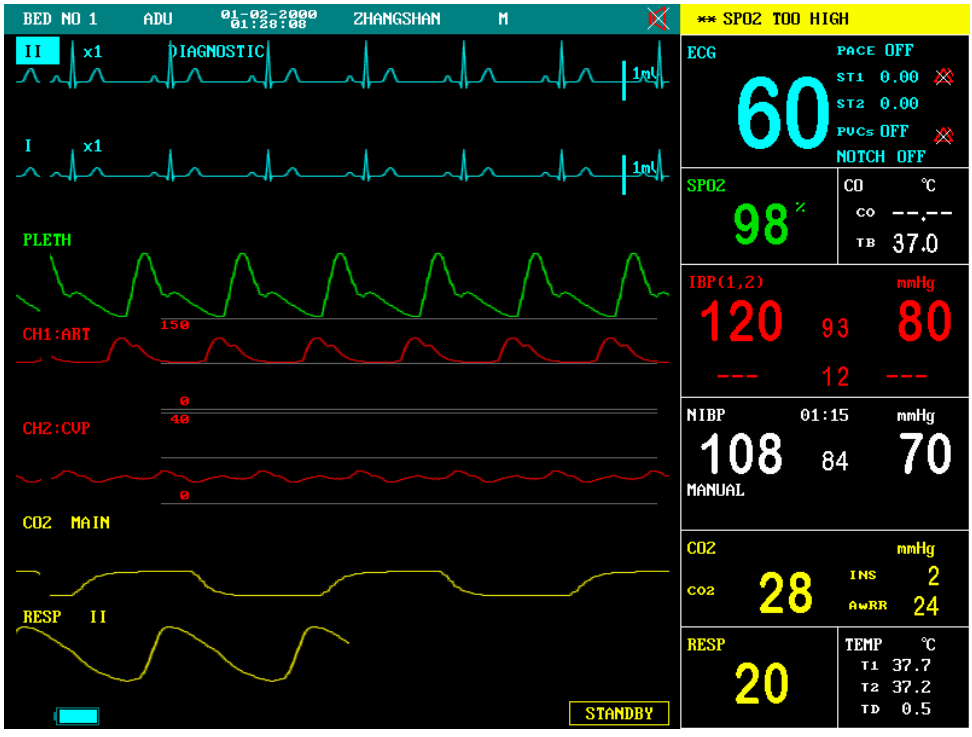


Figure 5-2 Standard Screen

5.2 Trend Screen

To enter the following screen, select TREND SCREEN in FACE SELECT menu and then select EXIT.

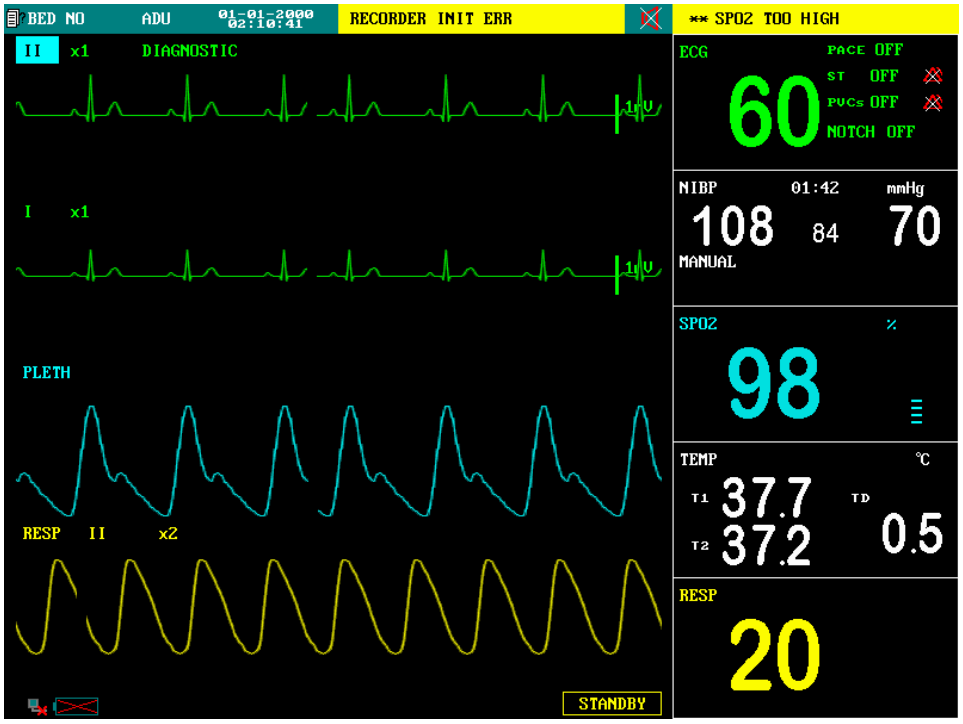


Figure 5-3 Trend Screen

■ Trend graph

Trend graphs locate to the right of the corresponding waveform in the waveform area, and display the trends of one parameter of each module. The parameter labels, as well as their scales, are displayed to the left of the trend graph.

■ Trend length

The dynamic trend length, located below the trend graph, is 2 hours. On the trend graph, the scale of the right end of the X-axis is 0 hour while the left end is -2 hour.

■ Selecting a trend parameter

If a module has multiple trend parameters, you can select one from the parameter label options of the corresponding trend graph. The trend graph of the selected parameter will be displayed. For example, in the ECG trend graph, you can select either from the parameter lable options, HR, ST and PVCs.

5.3 OxyCRG Screen

To enter the following screen, select oxyCRG SCREEN in FACE SELECT menu and then select EXIT.

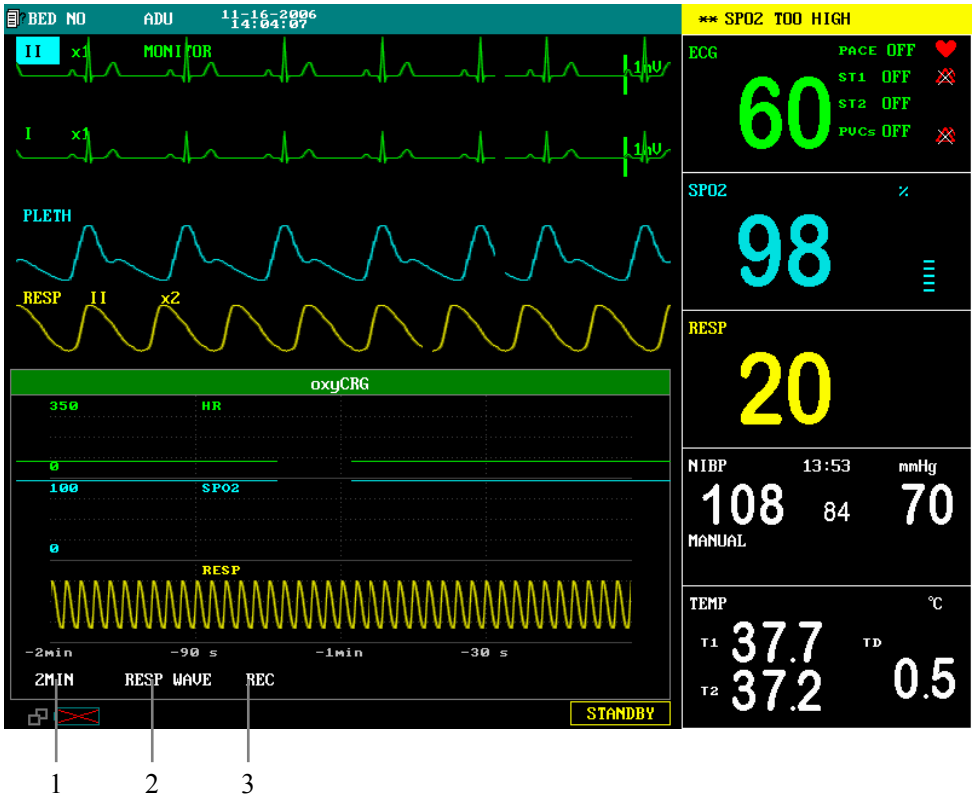


Figure 5-4 OxyCRG Screen

Oxy CRG screen is located at the lower part of the waveform area, consisting of the HR trend, the SpO_2 trend, and the RR (respiration rate) trend or the compressed respiration waveform. Below the RR trend or the compressed respiration waveform is the scale of the trend time. In addition, three labels are displayed beneath the time scale (see 1, 2 and 3 in the figure above). The labels are detailed as below.

1. Trend length

This label allows you to select the time duration of the trend graphs displayed. You can select either 1 MIN, 2 MIN or 4 MIN.

2. Compressed respiration waveform/RR trend

With this lable, you can select to display the compressed respiration waveform or the RR trend beneath the SpO_2 trend.

3. Recording

You can select the REC label to print out the the trends or the waveform displayed in the oxyCRG screen using the recorder.

5.4 Viewbed Screen

This monitor can view one parameter waveform and measured data from another patient monitor (viewbed monitor) on the same monitoring network. To enter the following screen, open FACE SELECT menu, select VIEWBED SCREEN, and then select EXIT.

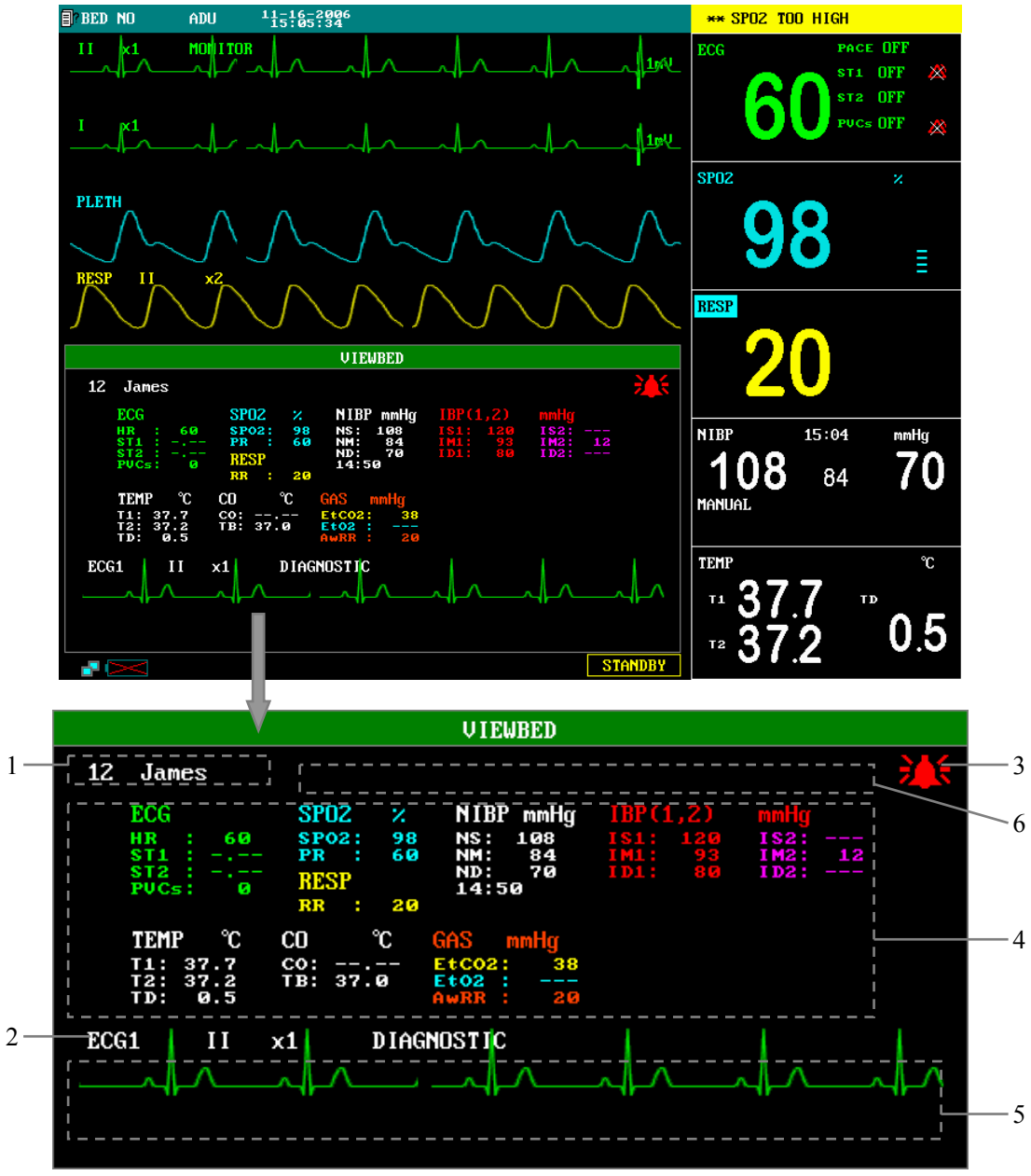


Figure 5-5 Viewbed Screen

The monitor you are viewing from is called “host monitor”. The monitor being viewed is called “viewbed monitor”. The viewbed screen is always displayed at the lower part of the host monitor’s waveform area. As shown in Figure 5-5, it consists

of the following parts.

1. Viewbed monitor label

The viewbed monitor lable allows you to select the viewbed monitor you want to view. It displays the bed number and patient name of the viewbed monitor. If they are not entered, the label displays blank. If the host monitor is not connected with any other monitor on the same network, the label displays N/A.

2. Viewbed waveform label

The viewbed waveform label allows you to select a waveform of the viewbed monitor. If the viewbed monitor does not dispaly any waveform, this label displays N/A.

3. Viewbed alarm indicator

The viewbed alarm indicator in the viewbed screen is used to indicate the alarm status of the viewbed monitor. Its color is identical with that of the viewbed monitor.

4. Viewbed parameter area

All parameter data of the viewbed monitor is displayed in this area.

5. Viewbed waveform area

The viewbed waveform area is located beneath the viewbed waveform label. It displays the waveform selected through the viewbed waveform label. The scan type (either refresh or scroll) and the sweep speed of the viewbed waveform follow the host monitor. Besides, information relating to the viewbed waveform is shown above the waveform.

6. Technical information area

On the right of the viewbed monitor label is the technical information area. It shows the technical information about viewing of other patient, such as the prompt information indicating failure in viewing other patient due to network problems.

Automatic Selection

When the viewbed screen is opened, the host monitor automatically selects a viewbed monitor on the same network and a waveform of this monitor to view. In case the monitor being viewed is disconnected, the host monitor automatically closes the display of alarms, parameters and the waveform of the viewbed monitor. However, the host monitor will not automatically select to view other monitor. You must make the selection using the viewbed monitor label manually.

If a parameter module of the viewbed patient monitor is turned off or disassembled, the corresponding waveform displayed on the host monitor disappears, and the viewbed waveform area becomes blank. At this time, you can use the viewbed waveform label to view other waveform.

NOTE

- **When connecting by wireless network, viewbed function is disabled.**

5.5 Large Font Screen

To enter the following screen, open FACE SELECT menu, select LARGE FONT SCREEN, and then select EXIT.

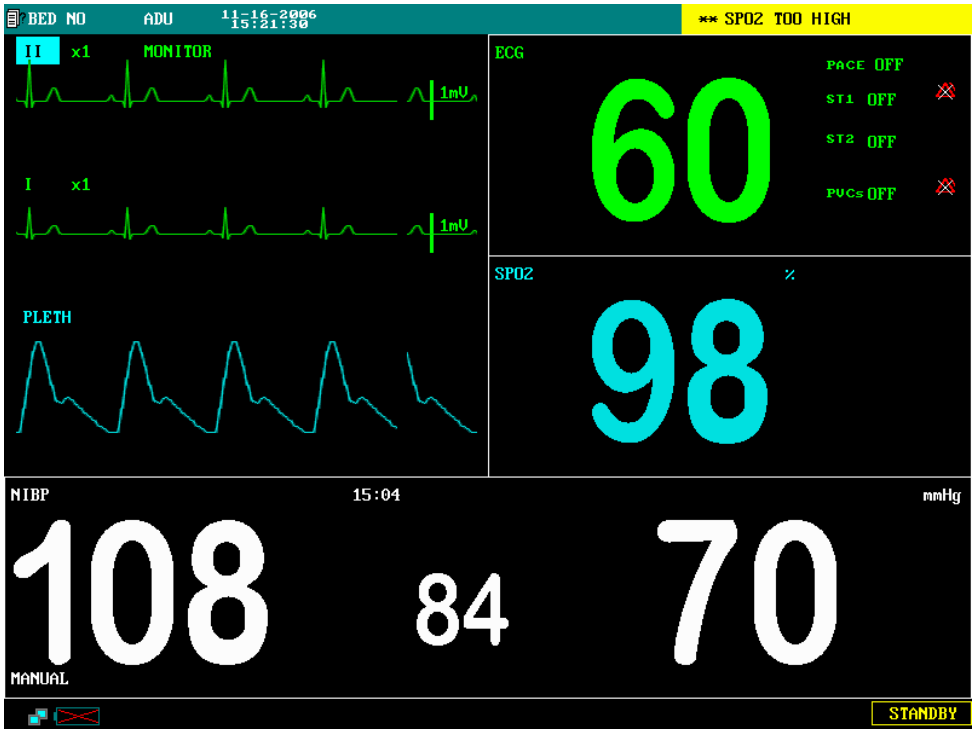


Figure 5-6 Large Font Screen

As shown above, the HR, SpO_2 and NIBP values (diastolic pressure, mean pressure and systolic pressure) are displayed in large font. The ECG and SpO_2 waveforms are displayed on the upper left of the screen. In case the ECG, SpO_2 or NIBP parameter module is turned off, the corresponding parameters and waveform disappear. If all the three modules are closed, no waveform or parameter is displayed on the screen.

NOTE

- **When you open a menu in the large font screen mode, the monitor will enter the standard screen automatically. When you exit the menu, the monitor will return to the large font screen.**
- **If MULTI-LEADS DISPLAY is selected in the ECG SETUP menu, the monitor cannot enter the large font screen.**

5.6 Standby Mode

During patient transport or temporary departure of a patient, the monitor can be set to STANDBY mode. In this mode, the monitor suspends the monitoring and measurement on the patient and shields all alarm indications. Besides the WORK MODE of CO_2 and AG module, which will also be changed to STANDBY, the previous menu settings and patient information keep unchanged.

Entering the STANDBY mode

1. Disconnect all leads and sensors between the patient and the monitor.
2. Select the STANDBY label at the lower right corner of the main screen. A dialog box pops up, and you can choose to enter the standby mode or not.
3. Select YES, and the monitor will enter the standby mode as shown below.
4. Select NO, and the monitor will return to the previous screen.



Figure 5-7 Standby Mode

Exiting the STANDBY mode

Press any key other than the power switch on the control panel or turn the control knob in the STANDBY mode, and a dialog box will pop up. Select YES in the dialog box, and you will exit the STANDBY mode and return to the previous screen.

6 Alarms

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6.1 Overview

The monitor gives audible or visual alarms to indicate the medical staff, when a vital sign of the patient appears abnormal, or mechanical or electrical problems occur to the monitor.

Upon turning on the monitor, a beep will be heard. At the same time, the alarm indicator will flash once in yellow and red. This is used to verify the audible and visual alarm function of the monitor. If no beep is heard, or the alarm indicator doesn't flash normally, please do not use the monitor, and contact our customer service.

For details about alarm setup of this monitor, please refer to ***4.4.2 Alarm Setup***.

6.1.1 Alarm Categories

The alarms are divided into three categories: physiological alarms, technical alarms and prompt information.

1. Physiological alarms

A physiological alarm either indicates that a monitored physiological parameter is out of specified limits or indicates an abnormal patient condition. For example: HR TOO LOW, ECG LOST or RESP ARTIFACT, etc. Physiological alarm messages are displayed in the physiological alarms area of the main screen.

2. Technical alarms

Technical alarms are also referred to as system error messages. A technical alarm indicates that the monitor or parts of the monitor is not capable of accurately monitoring the patient's condition due to improper operation or system failure. For example: ECG INIT ERR or TEMP SELFTEST ERROR, etc. Technical alarm messages are usually displayed in the technical alarms area of the main screen. But the technical alarms related to NIBP are displayed in the lower part of the NIBP parameter window.

3. Prompt information

Strictly speaking, prompt information cannot be counted in alarms. It is usually information relating to the system, but not concerning vital signs of patients. For

example, the monitor prompts ”NIBP alarm disabled ! ” at the time the monitor is powered on. Besides, if a parameter module is turned on but the required leads or sensor are not connected, the monitor will prompt accordingly, such as ”ECG LEAD OFF” or ”SPO2 SENSOR OFF”, etc. Prompt information is usually displayed in the technical alarms area. But the prompt information relating to NIBP is displayed in the lower part of the NIBP paramter window.

NOTE

- **To distinguish from the prompt information, the alarm message is displayed with yellow or red background.**

6.1.2 Alarm Levels

The alarms are divided into three priority levels: high level alarms, medium level alarms and low level alarms.

1. High level alarms

- The patient ‘s life is in danger and requires emergency treatment, or
- Serious technical problem occurs to the monitor, such as error in ECG module initialization.

2. Medium level alarms

- Vital signs of the patient become abnormal, and patient requires immediate treatment, or
- Certain technical problem occurs to the monitor, such as error in temperature calibration.

3. Low level alarms

- Certain technical alarm occurs to the monitor, such as ECG lead off in measurement.

The levels of all technical alarms and some physiological alarms are not user-adjustable, because they have been fixed when the monitor is produced. However, you can change the levels of some physiological alarms in the corresponding parameter setup menus.

All physiological alarms, technical alarms and prompt information are given in ***Appendix C Alarm Messages and Prompt Information***.

6.2 Alarm Modes

When an alarm occurs, the monitor raise the user's attention by the following audible or visual indications.

- Visual alarms
- Audible alarms
- Alarm messages
- Parameter flashes

Besides, the visual alarms, audible alarms and alarm messages are given in different ways to identify different alarm levels.

6.2.1 Visual Alarms

The alarm indicator on the front panel of the monitor varies its flash color and frequency to indicate different alarm levels.

- High level alarm: red and quick flash;
- Medium level alarm: yellow and slow flash;
- Low level alarm: yellow light without flash.

6.2.2 Audible alarms

The monitor uses different alarm tones to indicate different alarm levels.

- High level alarm: "DO-DO-DO--DO-DO---DO-DO-DO--DO-DO".
- Medium level alarm: "DO-DO-DO".
- Low level alarm: "DO".

Different intervals correspond to different alarm levels: High level alarm phonates once every 3 or 8 seconds. Medium level alarm phonates once every 14 or 24 seconds. Low level alarm phonates once every 24 seconds. For details, please refer to ***4.7 Maintenance***.

NOTE

- **When multiple alarms of different levels occur simultaneously, the monitor selects the alarm of the highest level and gives alarm tone accordingly.**

6.2.3 Alarm Messages

Alarm messages are given when alarms occur. The alarm messages are displayed in the physiological alarms area or the technical alarms area in black. For physiological alarms, asterisks are displayed before the alarm messages to identify the alarm level.

- High level alarms: triple asterisks "***"
- Medium level alarms: dual asterisks "**"
- Low level alarms: single asterisk "*"

The monitor varies the background color of the technical and physiological alarm messages to indicate the alarm level.

- High level alarms: red background color
- Medium level alarms: yellow background color
- Low level alarms: yellow background color

NOTE

- **Comparing with an alarm message, the background color of prompt information is the same as that of the position where it appears.**
- **The NIBP technical alarm messages appear in the NIBP parameter window. For high level alarms, the text color is red; for medium and low level alarms, the text color is yellow. The background color is the same as the parameter window.**

6.2.4 Parameter Flashes

An alarm is triggered when a patient parameter exceeds the parameter limit. At the same time, the measured parameter value in the parameter window flashes every second. If the ALM LIMIT in the SELECTION menu is turned ON, the exceeded upper or lower alarm limit also flashes every second.

6.3 Alarm Statuses

When an alarm occurs, normally the monitor gives indications in the modes mentioned above as per the alarm level. If necessary, you can the set the monitor to the following alarm statuses.

-  Alarms Disabled
-  Alarms Paused
-  System Silenced
-  Alarms Silenced

6.3.1 Alarms Disabled

If the alarm switch of a parameter is turned off, the monitor does not generate alarms even if the measured parameter value exceeds the alarm limit. This status is called Alarms Disabled.

To disable the alarms of a parameter, you should open the setup menu of the parameter. Take heart rate (HR) as an example.

1. Rotate the control knob and highlight the ECG parameter label.
2. Press the control knob. The ECG SETUP menu pops up.
3. Rotate the control knob and highlight the field on the right of HR ALM.
4. Press the control knob, and then select OFF from the pull-down list.
5. The HR alarms are disabled. The  icon will be displayed on the right of the ECG parameter label.

NOTE

- **When a new parameter module is installed or when a parameter module is turned ON, all the parameter alarms and technical alarms related to this module are disabled in the first 30-second operating time. The other module alarms are not influenced.**

6.3.2 Alarms Paused

To pause all alarms of the monitor for 1, 2 or 3 minutes, press the SILENCE key on the control panel once (for less than 2 seconds). In Alarms Paused status,

- Visual alarms and audible alarms are both paused.
- The parameters generating physiological alarms and their upper or lower limits stop flashing.
- Alarm messages are not displayed.
- The physiological alarms area shows the rest time of alarms paused status.
- The  icon will be displayed in the sound icon area.

The monitor will not terminate the Alarm Paused status even if a new technical or physiological alarm occurs during the alarms paused time.

6.3.3 System Silenced

To silence the system, press the SILENCE key for no less than 2 seconds. In the System Silenced status, all system sounds are shielded and the  icon is displayed in the sound icon area. However, other modes of alarms (excluding audible alarms) are given as normal. If a new alarm occurs, the System Silenced status will be terminated.

The system sounds include the audible alarms, key tones, heart beat tones and pulse tones. Among them, key tones refer to the sounds produced when the control knob is rotated and pressed.

6.3.4 Alarms Silenced

In Alarms Silenced status, all audible alarms are suppressed, but other modes of alarms and other sounds are not influenced. The  icon will be displayed in the sound icon area. To silence the audible alarms, first access the USER MAINTAIN menu, and then set the ALARM SOUND to OFF. For details, please refer to ***4.7 Maintenance***.

6.3.5 Status Switchover

1. In the Normal status,

- Press the SILENCE key for less than 2 seconds to switch to the Alarms Paused status, or
- Press the SILENCE key for 2 seconds or more to switch to the System Silenced status.

2. In the Alarms Paused status,

- Press the SILENCE key for less than 2 seconds to switch to the Normal status, or
- Press the SILENCE key for 2 seconds or more to switch to the System Silenced status.

3. In the System Silenced status,

- Press the SILENCE key for less than 2 seconds to switch to the Alarms Paused status, or
- Press the SILENCE key for 2 seconds or more to switch to the Normal status.

4. In the Alarms Silenced status,

- Enter the ALARM SETUP menu and set ALARM VOL to any setting other than 0. The alarm sound is restored.
- Enter the USER MAINTAIN menu and set ALARM SOUND OFF to DISABLE. The system restores the default alarm volume.

6.4 Latching Alarms

As described in ***4.4.2 Alarm Setup***, the parameter alarm type can be set to either LATCH or UNLATCH.

If the parameter alarm type is set to LATCH, before or during the occurence of a parameter alarm, the alarm message will be latched even if the initial alarm condition has ceased. The alarm messsage continues to be displayed, but the alarming modes change as follows:

- The measured parameter value and the upper or lower parameter limits stop flashing.
- The generated time of the alarm is displayed behind the alarm message in the physiological alarms area.

If the parameter alarm type is set to UNLATCH, the monitor stops giving any indication for this alarm when the initial alarm condition has ceased.

6.5 Clearing Alarms

Generally the alarm indications of an alarm will automatically be cleared when the alarm condition that triggered the alarm ceases. However, you can also clear the alarm indications or the latched alarms by the following ways.

1. Clearing audible and visual alarm indications

For some technical alarms, the audible and visual alarm indications will be cleared if the monitor is set to the Alarms Paused status (by pressing the SILENCE key for less than 2 seconds), and the alarm message will be changed to prompt information during and after the alarms paused time. If the technical alarm is triggered again after the monitor restores to the normal status, the monitor will give alarming indications as normal.

Please refer to ***Appendix C Alarm Messages and Prompt Information*** to see for which technical alarms that the audible and visual indications can be cleared.

2. Clearing all alarm indications

For some technical alarms, if the monitor is set to the Alarms Paused status (by pressing the SILENCE key for less than 2 seconds), all alarm indications will be cleared during and after the alarms paused time. If the technical alarm is triggered again after the monitor restores to the normal status, the monitor gives alarming indications as normal.

Please refer to ***Appendix C Alarm Messages and Prompt Information*** to see for which technical alarms that all alarm indications can be cleared.

3. Clearing latched alarms

Clearing latched alarms is also referred to as resetting alarms. It refers to clear the latched alarms by setting the monitor to the Alarms Paused status (by pressing the SILENCE key for less than 2 seconds).

6.6 When an Alarm Occurs

⚠WARNING

- **When an alarm occurs, always check the patient's condition first.**

When an alarm occurs to the monitor, refer to the following steps and take action properly.

1. Check the patient's condition.
2. Identify the alarming parameter and the alarm category.
3. Identify the cause of the alarm.
4. Take action to remedy the alarm cause.
5. Check if the alarm is cleared.

For details about how to deal with specific alarms, see ***Appendix C Alarm Messages and Prompt Information.***

FOR YOUR NOTES

7 Freezing Waveforms

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7.2 Freezing and Unfreezing 7-2
7.3 FROZEN Menu 7-3
7.4 Waveform Recall 7-4
7.5 Recording Frozen Waveforms 7-4

7.1 Overview

You can freeze the monitored waveforms of a patient as desired and view the waveforms of 40 seconds to gain a clear observation. Besides, the monitor can print two frozen waveforms using the recorder.

The freezing function of the monitor has the following features.

- When the monitor enters the frozen mode, it exits all other menus automatically.
- The system freezes all waveforms displayed in the waveforms area.
- The monitor can freeze waveforms in any screen type except for the STANDBY mode screen.
- The frozen waveforms can be reviewed and recorded.

7.2 Freezing and Unfreezing

Entering the Frozen Mode

1. Press the FREEZE key on the control panel when the monitor is not in frozen mode.
2. The system exits all displayed menus (if displayed), and the FROZEN menu pops up.

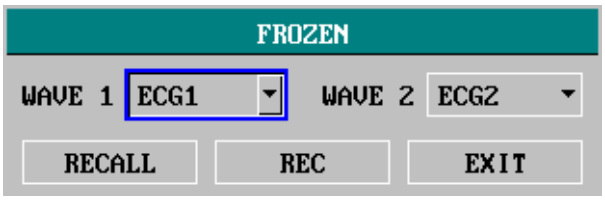


Figure 7-1 Frozen Menu

3. All displayed waveforms are frozen. In other words, the waveforms stop being refreshed or scrolling.

Exiting the Frozen Mode

To exit the frozen mode,

- Select EXIT in the FROZEN menu, or

- Press the FREEZE key on the control panel again.

After exiting the frozen mode, all waveforms on the screen are cleared and new real-time waveforms are displayed. If the scan type of the monitor is set to REFRESH, the waveforms are refreshed from the left of the waveforms area to the right ; if the scan type is set to SCROLL, the waveforms are displayed from the right of the waveforms area to the left and are scrolling.

7.3 FROZEN Menu

The FROZEN menu is displayed at the lower left corner. You can perform the following settings in this menu.

- WAVE 1 Waveform 1
  It determines the first frozen waveform to be printed on the recorder paper. The options of waveform 1 include all waveforms displayed on the screen and OFF. The waveform 1 will not be recorded when OFF is selected.
- WAVE 2 Waveform 2
  It determines the second frozen waveform to be printed on the recorder paper. The options of waveform 2 include all waveforms displayed on the screen and OFF. The waveform 2 will not be recorded when OFF is selected.
- RECALL Waveform recall
  It changes to L-RIGHT when selected. At this time, you can rotate the control knob to view the frozen waveform.
- REC Record
  When selected, the recorder starts printing out the selected waveform 1 and waveform 2.
- EXIT This option allows you to exit the FROZEN menu and unfreeze the waveforms.

7.4 Waveform Recall

1. In the frozen mode, select the RECALL option in the FROZEN menu, and the option name changes to L-RIGHT.
2. Rotate the control knob clockwise, and the frozen waveforms move to the right. At the lower right corner of the lowest waveform is an arrow pointing upward. The time is indicated below the arrow. The indication "0S" is used to mark the moment when the waveforms were frozen.
3. With the waveforms move to the right, the time mark, in turn, changes to -1S, -2S, -3S…
4. The time mark is applied to all waveforms displayed on the screen.
5. Rotate the control knob anticlockwise, and the waveforms move to the left.

7.5 Recording Frozen Waveforms

1. Select WAVE 1 and WAVE 2.
2. Select the REC option, and the recorder prints out the selected frozen waveforms and the parameters measured at the moment when the waveforms were frozen.
3. If OFF is selected from the WAVE 1 or WAVE 2 options, the recorder will merely print out one waveform and the parameters measured at the moment when the waveforms were frozen.
4. If OFF is selected from both the WAVE 1 and WAVE 2 options, the recorder will not print out any waveform and will merely print out the parameters measured at the moment when the waveforms were frozen.
5. The recording time length is identical to that of the waveforms displayed on the screen. If a waveform is of faster sweep speed, its recording time is shorter.
6. During waveform recording, the monitor is still in frozen mode.
7. When the recording completes, you can select to record other waveforms.
8. If the recorder is not installed, selecting the REC option or pressing the RECORD key triggers the "Recorder does not exit" message, which is displayed in the prompt information area.

8 Recording

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8.2 Recording Types 8-2
8.3 Recorder Operations 8-5
8.4 Installing Recorder Paper 8-9

8.1 Overview

A thermal recorder can be equipped with the monitor. The performance of the recorder is described as below.

- Records patient information and parameters.
- Records a maximum of two waveforms.
- The optional recording rates: 25mm/s and 50mm/s.
- The recording grid is optional.
- Multiple recording types are supported.

For details about the recorder setup, please refer to ***4.4.4 Recorder Setup***.

8.2 Recording Types

The monitor supports the following types of recordings:

- Real-time recording: continuous real-time recording or 8-second real-time recording.
- Automatic recording.
- Alarm recording: measured parameter alarm, ST segment alarm, or arrhythmia alarm recording.
- Frozen waveform recording.
- Trend graph/table recording: trend graph, trend table, NIBP measurement, alarm event or arrhythmia recording.
- CO measurement curve recording.
- Hemodynamic calculation recording.
- Titration table recording.
- OxyCRG recording.
- Monitor status information recording.

Real-time recording

Pressing the RECORD key on the control panel, the real-time recording starts and the current parameters and waveforms are recorded. As described in ***4.4.4 Recorder Setup,*** you can set the RT REC TIME to 8S or CONTINUUM in the RECORD

menu. You can also select the two waveforms (REC WAVE 1 and REC WAVE 2) to be recorded. If one of the two waveforms is set to OFF, the recorder will merely print out one waveform and all the measured parameters; if both are set to OFF, the recorder will only print all the measured parameter.

Automatic recording

The monitor starts recording at the selected interval (TIMING REC TIME) and record for 8s waveforms automatically. For details, see ***4.4.4 Recorder Setup***.

Alarm recording

Alarm recording includes measured parameter recording, ST segment alarm recording and arrhythmia alarm recording.

1. Parameter alarm recording

When a parameter alarm occurs, the recorder automatically records two waveforms of 8, 16 or 32 seconds (respectively 4, 8 or 16 seconds before and after the alarm. See ***4.4.2 Alarm Setup***) and all measured parameters.

2. ST segment alarm recording

In case of an ST segment alarm, the recorder automatically prints two ECG waveforms of 8, 16 or 32 seconds (respectively 4, 8 or 16 seconds before and after the alarm) and all the measured parameters.

3. Arrhythmia alarm recording

In case of an arrhythmia alarm, the recorder automatically prints an ECG waveform of 8 seconds (respectively 4 seconds before and after the alarm) and all the measured parameters.

NOTE

- **For a parameter alarm recording, you must first set the ALM and ALM REC options to ON.**

Frozen waveform recording

In the frozen mode, the monitor can print the frozen waveforms displayed on the screen and the parameters measured at the moment when the waveforms were frozen. For details, see ***7.5 Recording Frozen Waveforms***.

Trend graph/table recording

When the trend graph/trend table or a recall window is opened, you can select the REC option to print out the trend graph, trend table, NIBP measurement, alarm event or arrhythmia event.

CO measurement curve recording

When the WINDOW FOR CO MEASUREMENT is opened, you can select the REC option to print the CO measurement curve after measurement.

Hemodynamic calculation recording

When the HEMOD WINDOW is opened, you can select the REC option to print the hemodynamic calculation result after measurement.

Titration table recording

You can select the TITRATION option in the DRUG CALC menu and open the TITRATION window. The REC option in the window allows you to print the calculation result of the titration table.

OxyCRG recording

In the oxyCRG screen, you can press the RECORD key on the control panel to print the three trend graphs or waveforms from the recorder.

Monitor status information recording

The REC option in the STATUS menu allows you to print the status information of the monitor.

8.3 Recorder Operations

Continuous real-time recording

1. Press the RECORD key to start recording.
2. Press the RECORD key again to stop the recording.

8-second real-time recording

1. Press the RECORD key to start recording.
2. The recording stops automatically in 8 seconds.

Automatic recording

1. The recorder starts recording automatically at the preset interval (RT REC TIME).
2. The recording stops automatically in 8 seconds.

Alarm recording

1. When an alarm occurs, the recorder starts recording automatically.
2. The recording stops automatically when the preset alarm recording time (ALM REC TIME) is over.

Frozen waveform recording

1. Press the FREEZE key to open the FROZEN menu.
2. Select WAVE 1 and WAVE 2.
3. Select the REC option to record.
4. When the recording completes, the recorder stops automatically.

Trend graph recording

1. Select TREND GRAPH>> in SYSTEM MENU to open the TREND GRAPH window.
2. Select the REC option to start recording.
3. When the recording completes, the recorder stops automatically.

Trend table recording

1. Select TREND TABLE>> in SYSTEM MENU to open the TREND TABLE window.
2. Select the REC option to start recording.
1. When the recording completes, the recorder stops automatically.

NIBP measurement recording

1. Select NIBP RECALL>> in SYSTEM MENU to open the NIBP RECALL window.
2. Select the REC option to start recording.
3. When the recording completes, the recorder stops automatically.

Alarm event recording

1. Select ALARM RECALL>> in SYSTEM MENU to open the ALARM RECALL window.
2. Select the alarm recall time in the START and END fields.
3. Select the ALARM RECALL>> option and open the ALARM RECALL window.
4. Select the REC option to start recording.
5. When the recording completes, the recorder stops automatically.

Arrhythmia alarm recording

1. Select the ECG label in the ECG parameter window to the ECG SETUP menu pops up.
2. Select the ARR ANALYSIS >> option in the ECG SETUP menu, and a popup menu is opened.
3. Select ARR RECALL>> to open the ARR RECALL window.
4. Select the WAVE >> option to open the ARR WAVE RECALL window
5. Select REC to start recording.
6. When the recording completes, the recorder stops automatically.

CO measurement curve recording

1. Select the CO label in the parameter area to open the C.O. SELECT menu.
2. Select C.O. MEASURE option to open the WINDOW FOR CO MEASUREMENT.
3. Press START option to start a CO measurement.
4. Press REC option to start recording.
5. When the recording completes, the recorder stops automatically.

Hemodynamic calculation recording

1. Select EDIT>> in the WINDOW FOR CO MEASUREMENT to open the WINDOW FOR C.O. EDIT.
2. Select HEMO CALCULATE>> to open the HEMOD WINDOW.
3. Input the value of corresponding parameters, and then select CALCULATE option to start the calculation.
4. Press REC option to start recording.
5. When the recording completes, the recorder stops automatically.

Titration table recording

1. Select DRUG CALC >> in SYSTEM MENU.
2. Perform the drug calculation, and then select the TITRATION >> option.
3. Select the REC option to start recording.
4. When the recording completes, the recorder stops automatically.

OxyCRG recording

1. Enter the OxyCRG screen.
2. Select the RECORD key when the OxyCRG screen is displayed, and the recorder starts recording.
3. When the recording completes, the recorder stops automatically.

Monitor status information recording

1. Select MAINTAIN >> in SYSTEM MENU, and a popup menu is opened.
2. Select STATUS >> in the popup menu.
3. Select the REC option in the STATUS menu to start recording.
4. When the recording completes, the recorder stops automatically.

8.4 Installing Recorder Paper

Installing Procedure

1. Press the latch at the upper right of the paper compartment door to releases the door.
2. Lift the roller lever located at the upper left of the paper compartment as shown in the following figure.
3. Insert a new roll of recorder paper into the compartment as shown below.
4. The roller of the recorder scrolls automatically, and the paper comes out of the compartment.
5. Push down the roller lever.
6. Close the recorder door.

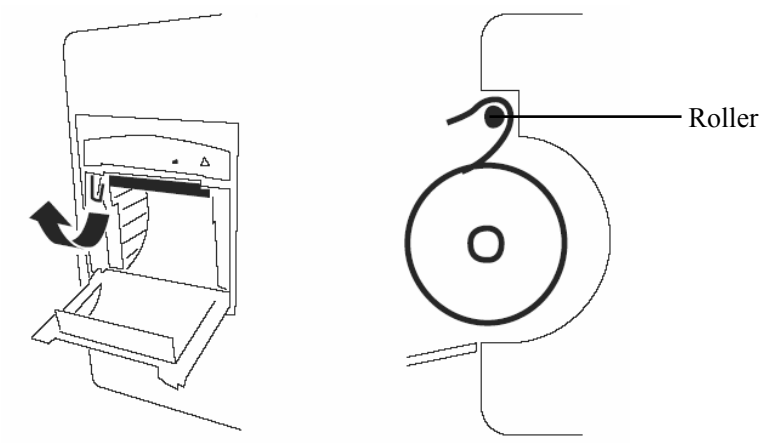


Figure 8-1 Installing Recorder Paper

⚠CAUTION

- **Use the specified recorder paper only. Other recorder paper may cause the recorder to print with poor quality, function improperly or not at all, or bring damage to the thermal print head.**
- **Do not pull the recorder paper with force when the printing is in process. Otherwise, damages to the recorder may be incurred.**
- **Do not leave the recorder door open except you are replacing the recorder paper or removing a fault.**

Removing the Paper Jam

If the recorder does not function properly or produces unusual sound, open the recorder door to check for a paper jam. You can follow the operations below to remove the paper jam.

1. Open the recorder door.
2. Tear the paper off from the leading edge at the paper outlet.
3. Lift the lever on the upper left of the recorder.
4. Pull the paper from the paper inlet.
5. Re-insert the paper.

9 Recall

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9.1 Overview

The monitor is able to store important patient data so that the user can review and record the data as desired.

- Trend Graph Recall

You can review the latest 1-hour trend graph of a measured parameter displayed every 1 or 5 seconds, or the latest 96-hour trend graph displayed every 1, 5 or 10 minutes.

- Trend Table Recall

You can review the latest 96-hour trend table data of a measured parameter.

- NIBP Recall

You can review 800 NIBP measurement results, each of which include a systolic pressure, a mean pressure, a diastolic pressure , a pulse rate and a measurement time.

- Alarm Event Recall

You can review the latest 70 parameter alarm events, as well as the 8, 16, or 32-second waveforms stored at the time of the alarm.

- Arrhythmia Event Recall

You can review the latest 80 arrhythmia events and the related 8-second waveforms.

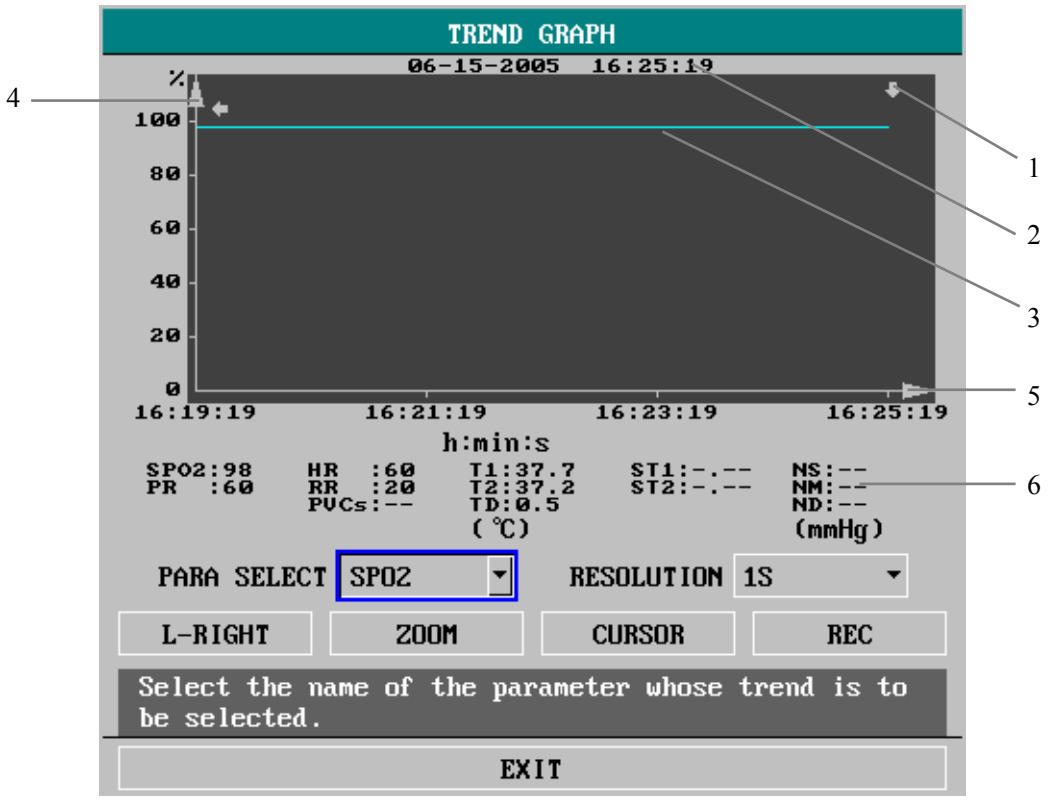
This chapter only gives introduction to the first four recalls mentioned above. For details about the arrhythmia event recall, please refer to ***11 ECG/RESP Monitoring***.

NOTE

- **When your monitor is powered off or the power is interrupted accidentally, all the stored data is lost, if the monitor is not equipped with the fuction of "Power-off Data Storage".**

9.2 Trend Graph Recall

Select TREND GRAPH >> in SYSTEM MENU. The following window appears.



1. Trend cursor 2. Cursor time 3. Trend graph
4. Y-axis 5. X-axis 6. Parameters area

Figure 9-1 Trend Graph

As shown above, PARA SELECT allows you to select a parameter from the options. The trend graph of the selected parameter is displayed. If NIBP is selected, no trend graph is to be displayed. Instead, the ▼ mark indicates the systolic pressure, the ▲ mark indicates the diastolic pressure and the * mark indicates the mean pressure. The x-axis shows the time scale while the y-axis shows the value scale of a parameter. The trend cursor is used to identify a specific time in the whole trend time, and it is displayed below the title “TREND GRAPH”. All the parameter values measured at the time of the cursor are displayed in the parameters area.

■ PARA SELECT (Parameter Selection)

1. Rotate the control knob and highlight the field at the right PARA SELECT.
2. Press the control knob, and a popup menu with all parameter options is opened.

3. Rotate the control knob and highlight your desired parameter, and then select it. The trend graph of the selected parameter is displayed in the TREND GRAPH window.

■ RESOLUTION

1. Rotate the control knob and highlight the field at the right of RESOLUTION.
2. Press the control knob, and a menu pops up.
3. Select 1S or 5S to review a 1-hour trend graph, or
4. Select 1MIN, 5MIN or 10 MIN to review a 96-hour trend graph.

■ L-RIGHT

1. Rotate the control knob to highlight the L-RIGHT option, and then press.
2. If the  mark is displayed at the upper left corner of the trend graph, you can rotate the control knob anticlockwise to review the earlier trend graph.
3. If the mark  is displayed at the upper right of the trend graph, you can rotate the control knob clockwise to review the later trend graph.

■ ZOOM

1. Rotate the control knob to highlight the ZOOM option, and then press.
2. Rotate the control knob to adjust the vertical value scale.
3. The amplitude of the trend curve changes at the vertical direction accordingly. Any data that is beyond the maximum value of the scale will not be displayed. Instead, it is represented by the maximum scale value.

■ CURSOR

1. Rotate the control knob to highlight the CURSOR option, and then press.
2. Rotate the control knob, and the trend cursor moves as per the preset resolution.
3. The cursor time and the values displayed in the parameters area change accordingly.

■ REC (Recording)

The REC option allows you to print the currently displayed parameters and trend graph from the recorder.

■ Mark Event

If an event is marked A, B, C or D, the mark (A, B, C or D)will be displayed at the mark time on the trend graph.

NOTE

- **The chapter uses "earlier" or "later " to indicate the time that an event happened. For example, May 28 is earlier than May 29, and 8 :00 on May 29 is earlier than 9 :00 on May 29.**

9.3 Trend Table Recall

Select TREND TABLE >> in SYSTEM MENU. The following window appears.

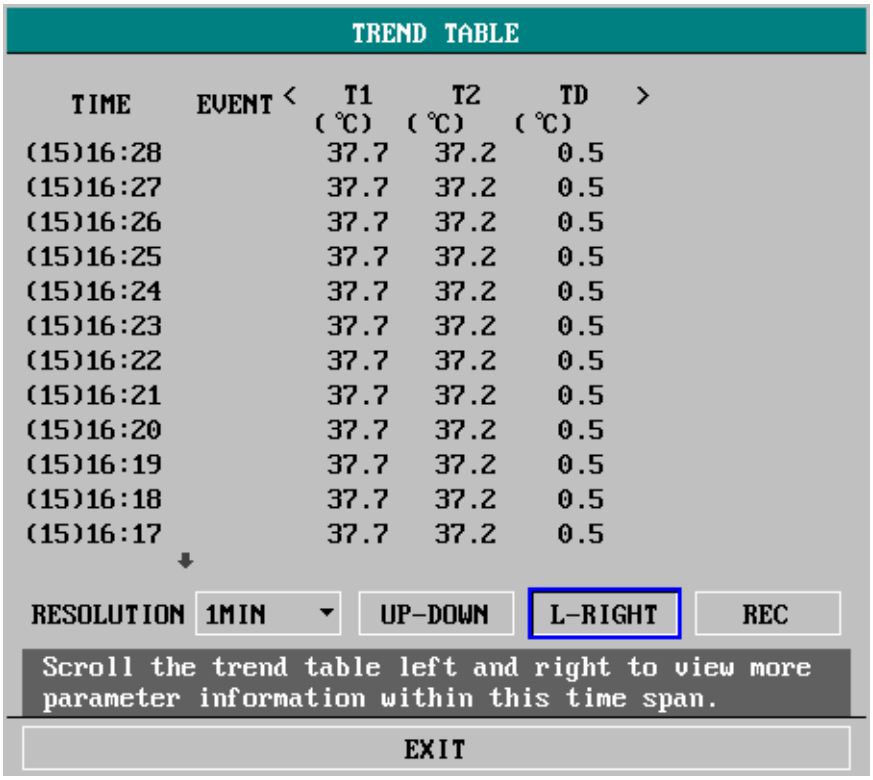


Figure 9-2 Trend Table

The TIME is displayed on the left of the trend table. On the top is the latest time. From the upper to the lower, the interval between two adjacent times depends on the preset resolution. And the date is contained in the brackets. On the right of the TIME is the EVENT. If a marked event happened at a specific time, the mark will be displayed aside that time in the EVENT field. On the right of the trend table are parameter names and the trend data. The symbol "－－" means the parameter is not measured at the corresponding time. Besides, the L-RIGHT option allows change of the parameter name and the trend data.

If you select to review the NIBP trend data, the measurement results as well as the specific measurement time (in the TEST AT filed) are displayed.

- RESOLUTION

1. Rotate the control knob to highlight the field at the right of RESOLUTION.
2. Press the control knob, and a popup value with the options, 1MIN, 5 MIN, 10MIN, 30MIN and 60MIN, is opened.
3. The time displayed in the TIME filed changes with the resolution.

- UP-DOWN

1. Rotate the control knob to highlight the UP-DOWN option, and press.
2. If the  mark is displayed at the lower right of the TIME field, you can rotate the control knob anticlockwise to page down and review the trend data of earlier time.
3. If the  mark is displayed at the upper right of the TIME field, you can rotate the control knob clockwise to page up and review the trend data of later time.

- L-RIGHT

1. Rotate the control knob to highlight the L-RIGHT option, and then press.
2. Rotate the control knob to select a parameters set.

The “>” mark on the right of the parameter names indicates the following page is available, and the “<” mark on the left of the parameter names indicates the previous page is available.

3. The parameter names and the trend data changes with the selected parameter set.

- REC

The REC option allows you to print out the trend data of the currently displayed parameter(s).

- Mark Event

If an event is marked A, B, C or D, the mark (A, B, C or D) will be displayed aside the mark time on the trend table.

9.4 NIBP Recall

Select NIBP RECALL >> in SYSTEM MENU. The following window appears.

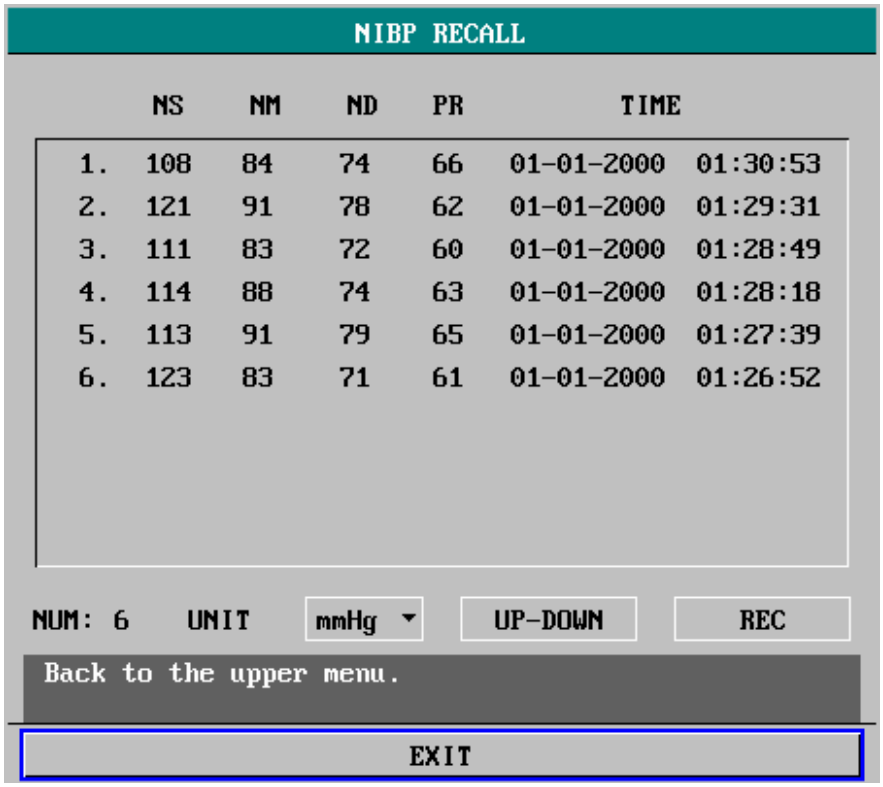


Figure 9-3 NIBP Recall

The NIBP RECALL window shows the non-invasive systolic pressure (NS), non-invasive mean pressure (NM), non-invasive diastolic pressure (ND), puse rate (PR) and the measurement time (TIME). The optional pressure units (UNIT) are mmHg and kPa. NUM indicates the current measurement times. PR is derived from SpO_2 measurements. A maximum of ten measurements can be displayed on the screen once. If there are more, you may use the UP-DOWN option to review the data of a later or earlier time. If the measurement times surpass 800, only the latest 800 measurements are to be displayed. The REC option allows you to print out all measurement data of NIBP RECALL.

9.5 Alarm Event Recall

Select ALARM RECALL >> in SYSTEM MENU. The following menu appears.

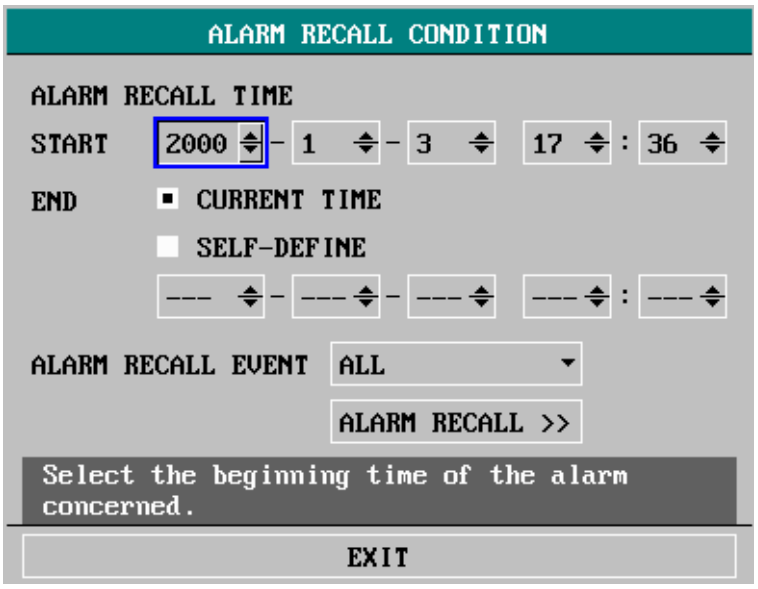


Figure 9-4 Alarm Recall Condition Selections

In this menu, you may select the conditions of alarm review:

- ALARM RECALL TIME

You can select the desired start time and end time for review. The end time can be set to either CURRENT TIME or SELF-DEFINE.

- ALARM RECALL EVENT

The drop-down menu of ALARM RECALL EVENT provides a list of parameter options to be reviewed. Among them, ALL indicates all parameter alarm events are to be reviewed, H refers to the upper parameter limit and L refers to the lower parameter limit.

- ALARM RECALL>>

If the ALARM RECALL TIME and the ALARM RECALL EVENT are both selected, you can select the ALARM RECALL >> option to open the ALARM RECALL window as shown in Figure 9-5.

This window contains the following information:

1. Time span (the start time and end time of alarm recall).
2. Alarm event type.
3. The alarming parameter, parameter value, alarm level and the alarm time.

4. The alarm event number (format: NO: n of N). N indicates the amount of alarm events and n indicates the sequence number of the currently displayed alarm event.
5. Parameter values at the time of the alarm event.
6. Two waveforms at the time of the alarm event. You can set the waveform length by selecting from the ALM REC TIME options in the ALARM SETUP menu. Please refer to ***4.4.2 Alarm Setup***.

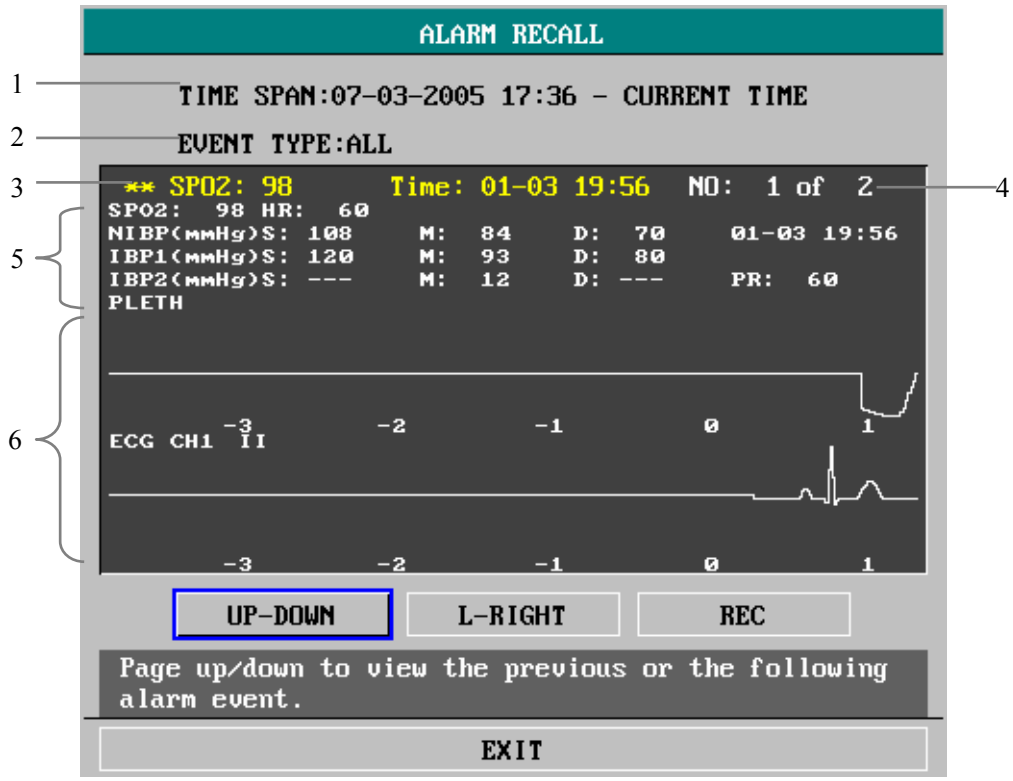


Figure 9-5 Alarm Event Recall

■ UP-DOWN

The monitor is able to store a maximum of 70 alarm events. But only one alarm event can be displayed in the ALARM RECALL window once. You can select the UP-DOWN option and then rotate the control knob to view an earlier or later alarm event.

■ L-RIGHT

You may select the L-RIGHT option and then rotate the control knob to review the 8,16,or 32-second waveforms stored.

■ REC

This option allows you to print out all parameter data and waveforms displayed in the current window using the recorder.

9.6 Non-Volatile Data Storage

To avoid losing patient's data when the monitor is powered off intentionally or accidentally, this monitor can be equipped with a CF storage card (optional) to realize the non-volatile data storage function. During monitoring, the patient's data, including trend data, NIBP measurement results, alarm events, arrhythmia events, and relative waveforms, will be saved into the CF storage card. When the monitor is powered on again, you can review the saved data using the TREND GRAPH, the TREND TABLE, the NIBP RECALL or the ARR RECALL menu, etc.

10 Drug Calculation

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10.2 Titration Table 10-5

10.1 Drug Calculation

Select DRUG CALC >> in SYSTEM MENU. The following window appears.

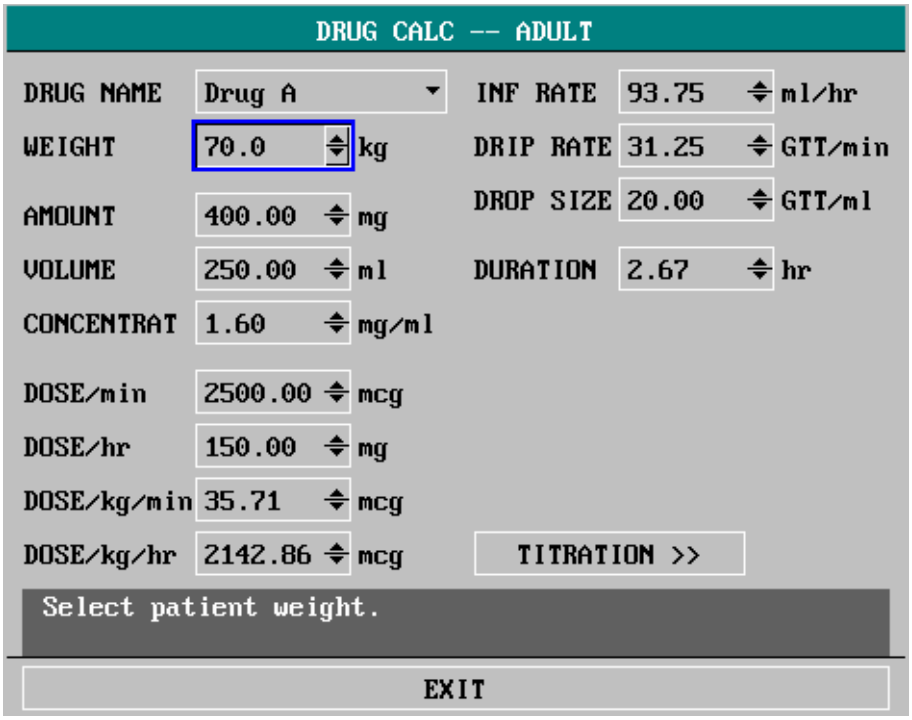


Figure 10-1 Drug Calculation

10.1.1.1 Calculation Formula

CONCENTRAT = AMOUNT/VOLUME
INF RATE = DOSE/CONCENTRAT
DURATION = AMOUNT/DOSE
DOSE = INF RATE×CONCENTRAT

10.1.1.2 Operating Method

1. Select the drug name

Open the drop-down menu of DRUG NAME and select one from the following 15 options:

- DRUG A, B, C, D and E
- AMINOPHYLLINE
- DOBUTAMINE

- DOPAMINE
- EPINEPHRINE
- HEPARIN
- ISUPREL
- LIDOCAINE
- NIPRIDE
- NITROGLYCERIN
- PITOCIN

NOTE

- **The DRUG names A, B, C, D and E are user-definable.**

2. Input the patient weight

Select the field on the right of WEIGHT and rotate the control knob to enter the patient weight correctly.

3. Input correct parameter values

The system gives a group of random initial values when the above operations are finisehd. However, these values cannot be used as the calculation reference. The operator shall enter a new group of correct values required in the calculation formula, according to the doctor's instruction.

4. Verify the correctness of the calculation results

After the calculation, the operator shall verify the correctness of the entered parameter values, so as to guarantee correct calculation results.

10.1.1.3 Units

Each drug has its fixed unit or unit series. The operator must select the proper unit according to the doctor's instruction. Among a unit series, one unit may change to another automatically depending on the entered parameter value. If a parameter value exceeds the system-defined range, "——" will be displayed. The units of the self-definable drugs are as follows :

1. DRUG A, B and C uses the unit series: g, mg and mcg.
2. DRUG D uses the unit series: Unit, k Unit and m Unit.
3. DRUG E uses the unit series: mEq.

NOTE

- **In neonate mode, DRIP RATE and DROP SIZE are disabled.**
- **The prerequisite for drug calculation is that the drug name and the patient weight are selected.**
- **The function of drug calculation is independent from other functions of the monitor. The patient information used for drug calculation may not consist with the patient of your monitor. Any change in the DRUG CALC menu will not affect the information of the patient under monitoring.**

⚠WARNING

- **The random values given by monitor cannot be used as the calculation reference.**
- **After the drug calculation, verify the entered parameters are correct and the calculation results are proper. We are not responsible for the consequence caused by wrong entering and operation.**

10.2 Titration Table

After the drug calculation, select TITRATION in DRUG CALC window. The following window pops up.

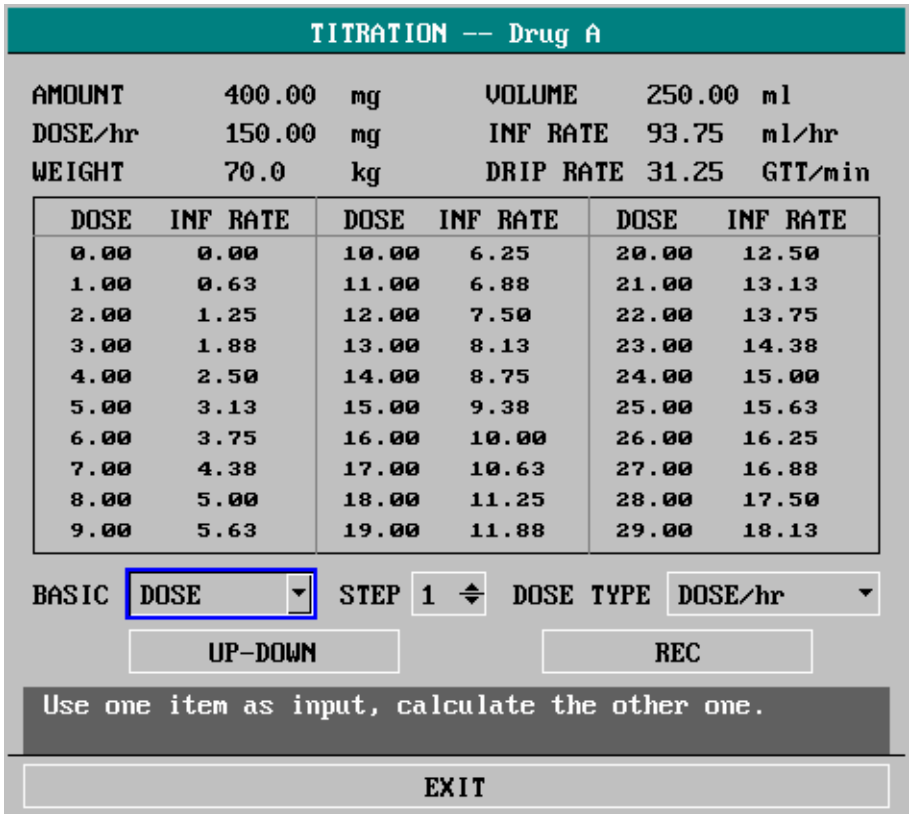


Figure 10-2 Titration Table

■ BASIC

1. Rotate the control knob to highlight the field on the right of BASIC.
2. Press and rotate the control knob to select DOSE, INF RATE or DRIP RATE.
3. The data in the trend table changes accordingly.

■ STEP

1. Rotate the control knob to highlight the field on the right of STEP.
2. Press and rotate the control knob to select a value in the range of 1-10.
3. The data in the trend table changes accordingly.

- DOSE TYPE

1. Rotate the control knob to highlight the field on the right of DOSE TYPE.
2. Press and rotate the control knob to select either DOSE/min, DOSE/hr, DOSE/kg/min or DOSE/kg/hr in the popup menu.
3. The data in the trend table changes accordingly.

- UP-DOWN

1. Rotate the control knob to highlight the UP-DOWN option in the window.
2. Rotate the control knob to review more data.

- REC

The REC option allows you to print the currently displayed data from the recorder.

NOTE

- **The titration table is independent from other functions of the monitor. The patient information used in the titration table may not consist with the patient of your monitor. Any change in the titration table will not affect the information of the patient under monitoring.**

11 ECG/RESP Monitoring

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11.1 Overview

11.1.1 ECG Waveform

In the standard screen, one or two ECG waveform(s) is (are) displayed at the top of the display when LEAD TYPE is set to 3 LEADS or 5LEADS respectively in the ECG SETUP menu.

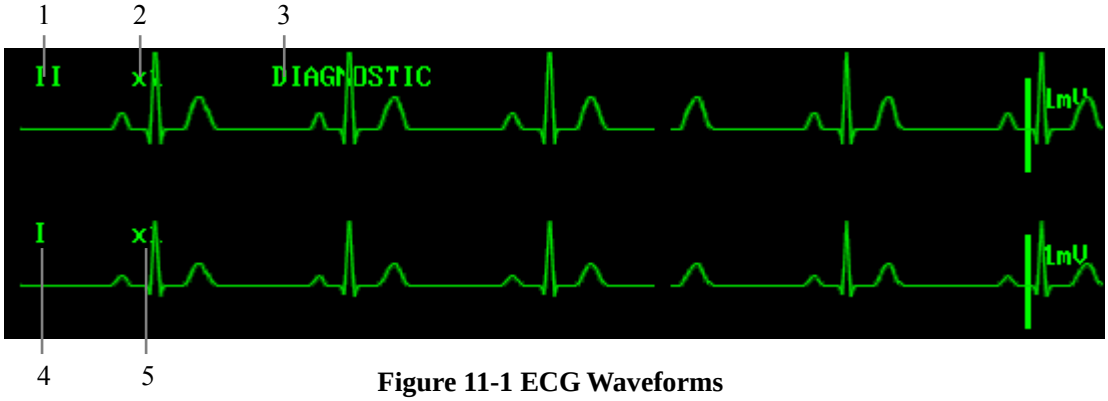


Figure 11-1 ECG Waveforms

As shown above, when 5 LEADS is selected, five labels are located above the ECG waveforms:

1. ECG lead of channel 1

You can select the lead of channel 1 from the label options.

- When you use a 3-lead set, the monitor gives three lead options: I, II and III;
- When you use a 5-lead set, the monitor gives seven lead options: II, III, aVR, aVL, aVF, V and I.

2. Gain of the channel-1 waveform

You may use this label to adjust the amplitude of the channel-1 ECG waveform. The gain options include ×0.125, ×0.25, ×0.5, ×1, ×2 and AUTO. When AUTO is selected, the monitor adjusts the gain automatically. Besides, a 1mV scale is displayed at the right side of each ECG waveform. The height of the 1mV bar is directly proportional to the ECG waveform amplitude.

3. Filter Method

The filtering enables clearer and more detailed waveforms. There are three filter methods for selection.

- DIAGNOSTIC: The monitor displays the ECG waveforms without filter;
- MONITOR: It effectively filters the artifacts that might cause false alarms;
- SURGERY: This filter is used to reduce the artifacts and interference from electrosurgery equipment.

The selected filter is applied to both channels, but the filter label is merely displayed above the first ECG waveform.

⚠WARNING

- **Only in the DIAGNOSTIC mode will the monitor provide non-processed real signal waveforms. In the MONITOR or SURGERY mode, the ECG waveforms may have slight distortions and the result of the ST segment analysis may be affected greatly. In the SURGERY mode, the ARR analysis result may be affected to some extent. Hence, the DIAGNOSTIC mode is recommended when monitoring a patient in an environment with slight interference.**

4. ECG lead of channel 2: You can select the lead of channel 2 in the same method used to select the channel-1 lead.

5. Gain of the channel-2 waveform: You can adjust the gain of the channel-2 ECG waveform in the same method used for channel 1.

NOTE

- **If the amplitude of an ECG waveform is too large, the peak of the waveform might not be displayed. In this case, you should change the waveform gain properly.**
- **At present, the central monitoring system of us is unable to display an ECG waveform of the gain ×0.125. If your monitor is connected with this system, the ECG waveform displayed by the central monitoring system will be changed from ×0.125 to ×0.25.**
- **The selected leads of channel 1 and channel 2 should not be identical. Otherwise, the system will change one of them automatically. In the MULTI-LEADS DISPLAY mode or the HALF-SCN MUTLI-LEADS display mode, the leads of both channels cannot be set.**
- **A pacemaker signal, when detected, is marked by "ˈ" above the ECG waveform.**

11.1.2 ECG Parameters



Figure 11-2 ECG Parameters

The parameters related to ECG are displayed to the right of the ECG waveforms as shown above. The heartbeat indicator flashes in the same rate with the patient's heartbeat. On the right of the heart rate numeric are the ON/OFF status or value of PACE, ST1, ST2, PVCs and NOTCH.

11.2 ECG Monitoring Procedure

11.2.1 Preparation

1. Skin preparation

The quality of ECG information displayed on the monitor is a direct result of the quality of the electrical signal received at the electrode. Proper skin preparation is necessary for good signal quality at the electrode. A good signal at the electrode provides the monitor with valid information for processing the ECG data. Choose flat, non-muscular areas to place electrodes. Following is a suggested guideline for skin preparation:

- Shave hair from skin at chosen sites.
- Gently rub skin surfaces at sites to remove dead skin cells.
- Thoroughly cleanse the site with a mild soap and water solution (do not use ether or pure alcohol because they will increase skin impedance).
- Dry the skin completely before applying the electrodes.

2. Attach the ECG leadwire to the electrodes prior to placement.
3. Place the electrodes on the patient. If the conductive ointment is not applied to the electrodes, apply it before the placement.
4. Connect the electrode lead to the patient cable.
5. Make sure the monitor is turned on and is ready for monitoring.

11.2.2 Electrode Placement

⚠WARNING

- **Use only the specified ECG cable for monitoring.**
- **When applying electrodes or connecting cables, make sure they are not connected to any conductive part or the ground. Verify that all ECG electrodes, including neutral electrodes, are securely attached to the patient.**
- **Skin irritation may result from the continuous application of the ECG electrodes. These should be checked each day. If there is an indication of excess skin irritation, replace the electrodes or change the location of the electrodes every 24 hours.**
- **Do not touch the patient, bed or instrument during defibrillation.**
- **When applying the ECG cable with no resistance to our patient monitor or other patient monitor that has no current limit resistance in it, the monitor cannot be applied to defibrillation.**
- **Interference from a non-grounded instrument near the patient and ESU interference can cause inaccuracy of the ECG waveform.**
- **Always dispose of, or recycle electrodes properly to prevent from environment contamination.**
- **Verify the lead fault detection prior to the start of monitoring. Unplug the ECG cable from the ECG connector and the screen should display the error message “ECG LEAD OFF” and an audible alarm should be activated.**

11.2.2.1 5-Leadwire Electrode Placement

Following is the configuration per American standard when using five leadwires:

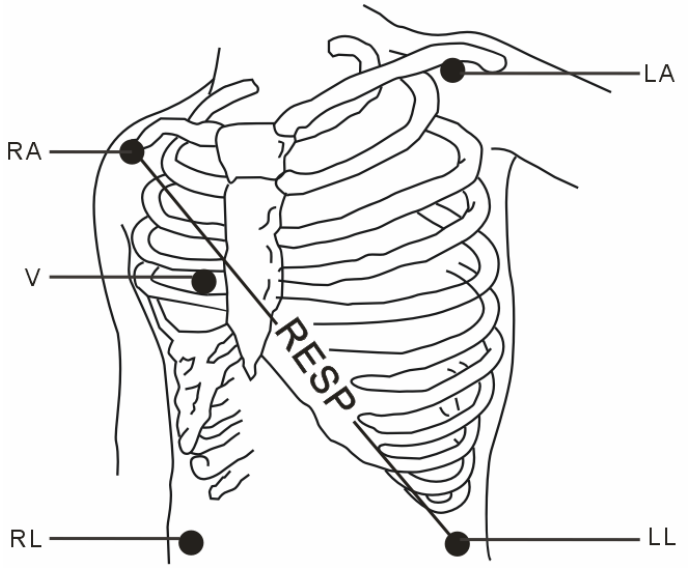


Figure 11-3 5-Leadwire Electrode Placement

- RA (right arm) electrode: near the right shoulder, directly below the clavicle.
- LA (left arm) electrode: near the left shoulder, directly below the clavicle.
- RL (right leg) electrode: on the right hypogastrium.
- LL (left leg) electrode: on the left hypogastrium.
- V (precordial) electrode: on the chest.

Attach the chest (V) electrode to one of the following positions indicated in Figure 11-4:

- V1: On the 4th intercostal space at the right sterna margin.
- V2: On the 4th intercostal space at the left sterna margin.
- V3: Midway between V2 and V4 electrodes.
- V4: On the 5th intercostal space at the left clavicular line.
- V5: On the left anterior axillary line, horizontal with V4 electrode.
- V6: On the left middle axillary line, horizontal with V4 electrode.
- V3R-V7R: On the right side of the chest in positions corresponding to those on the left.
- VE: Over the xiphoid.

When attaching the chest electrode to the back of a patient, place it at one the following sites:

- V7: On the 5th intercostal space at the left posterior axillary line of the back.
- V7R: On the 5th intercostal space at the right posterior axillary line of the back.

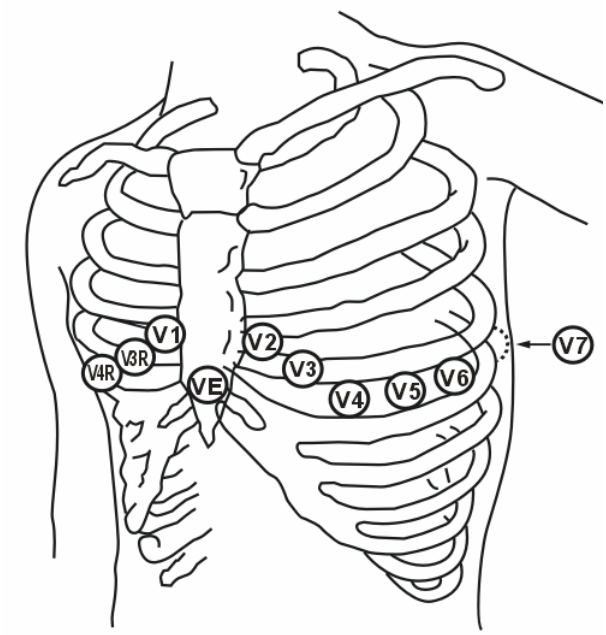


Figure 11-4 Positions of Chest Electrode

The chart below shows the label used to identify each leadwire. Included also is its associated color code per American (AHA) and European (IEC) standards.

American Standard		**European Standard**	
Label	Color	Label	Color
RA	White	R	Red
LA	Black	L	Yellow
LL	Red	F	Green
RL	Green	N	Black
V	Brown	C	White

11.2.2.2 3-Leadwire Electrode Placement

Following is the configuration per European standard when using three leadwires:

- R (right arm) electrode: near the right shoulder, directly below the clavicle.
- L (left arm) electrode: near the left shoulder, directly below the clavicle.
- F (left leg) electrode: on the left hypogastrium.

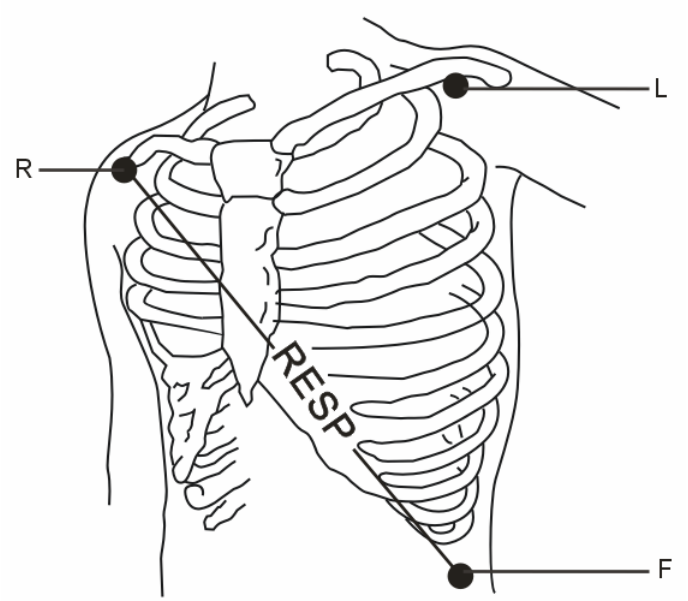


Figure 11-5 Positions of 3-Leadwire Electrode Placement

The chart below shows the label used to identify each leadwire. Included also is its associated color code per American (AHA) and European (IEC) standards.

American Standard		**European Standard**	
Label	Color	Label	Color
RA	White	R	Red
LA	Black	L	Yellow
LL	Red	F	Green

11.2.2.3 Electrode Placement for Surgical Patients

Electrode placement during surgery is dependent on the type of surgery being performed. For example, with open chest surgery, the electrodes might be placed laterally on the chest or on the back. In the operating room, artifact can sometimes affect the ECG waveform due to the use of electrosurgery equipment. To help reduce this, place the electrodes on the right and left shoulders, the right and left sides near the stomach, and place the chest lead on the left side at mid-chest. Avoid placing the electrodes on the upper arms. This will cause the ECG waveform to be too small.

⚠WARNING

- **When using Electrosurgery equipment, patient leads should be placed in a position that is equal distance from the Electrosurgery electrotome and the grounding plate to avoid burns to the patient. The Electrosurgery equipment wire and the ECG cable must be kept separated and not allowed to tangle.**
- **When using Electrosurgery equipment, never place the ECG electrodes near the grounding plate of the Electrosurgery device. This will cause a great deal of interference with the ECG signal.**

11.2.2.4 Characteristics of Quality ECG Signal

As shown in Figure 11-6, the normal QRS complex should exhibit the following characteristics.

- Tall and narrow with no notches.
- With a tall R-wave completely above or below the baseline.
- With a pacer spike no higher than the height of the R-wave.
- With the T-wave less than one-third of the height of the R-wave.
- With the P-wave much smaller than the T-wave.

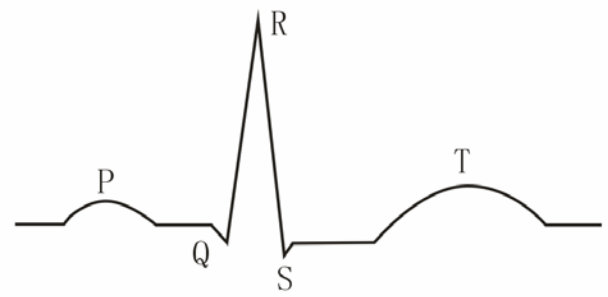


Figure 11-6 Standard ECG Waveform

To display a 1-millivolt calibration pulse on the ECG wave, select the ECG CAL option in the ECG SETUP menu. A message "when CAL, can't monitor! " is displayed on the screen.

NOTE

- **If the ECG waveform is too small, or not accurate, and the electrodes are secure and firmly attached to the patient, change the display to a different lead.**

11.3 ECG Setup Menu

Select the ECG label in the parameter windows. The following menu appears.

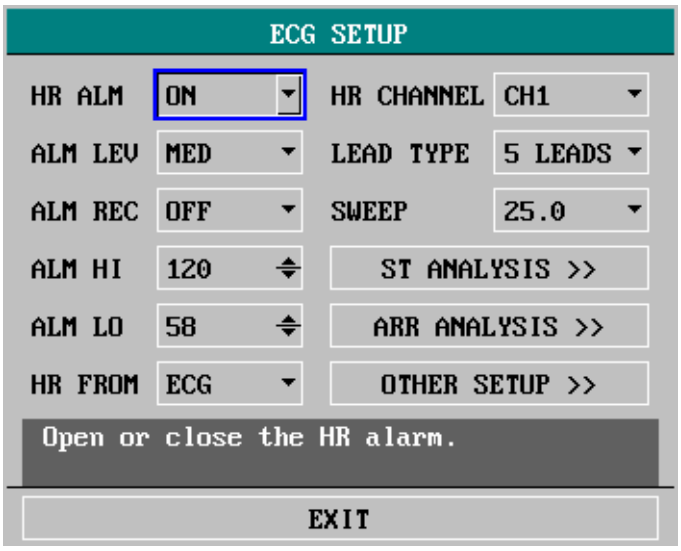


Figure 11-7 ECG SETUP Menu

In this menu, you can perform the following settings:

- HR ALM — Heart rate alarm on/off status
  ON: When a heart rate alarm occurs, the monitor gives alarm indications and stores the alarm;
  OFF: When a heart rate alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
  When OFF is selected, the icon is displayed on the right of the ECG label.
- ALM LEV — Alarm level
  Options: HIGH, MED and LOW.
- ALM REC — Alarm recording
  ON: When a heart rate alarm occurs, the monitor enables the recording;
  OFF: When a heart rate alarm occurs, the monitor does not enable the recording.
- ALM HI — Upper alarm limit
  Determines the upper ECG alarm limit.
- ALM LO — Lower alarm limit
  Determines the lower ECG alarm limit.

For different patient types, the upper/lower limits of the heart rate alarm may vary in the following range.

Patient type	Max. ALM HI	Min. ALM LO	Increment (beat/min)
Adult	300	15	1
Pediatric	350	15	1
Neonate	350	15	1

NOTE

- **Always set the alarm limits according to the clinical condition of the individual patient.**
- **In many cases, the upper limit of heart rate alarms should not exceed 20 beats per minute higher than the patient's heart rate.**

■ HR FROM Heart rate source
Options: ECG, SPO2, AUTO and BOTH

1. ECG: The monitor detects the heart rate through the ECG.
2. SPO2: The monitor detects the heart rate through the SPO2. PULSE is displayed to the right of the ECG label while the PR (pulse rate) value is displayed below. The monitor activates pulse beeps instead of heartbeat beeps. Besides, the monitor gives indications to PR alarms but gives no indication to the HR alarms.
3. AUTO: The monitor determines the heart rate source depending on the signal quality. The ECG takes priority of the SPO2. The SPO2 is selected as the heart rate source only if the quality of the ECG signal is too poor to be analyzed. Once the ECG signal restores to normal situation, it is selected as the heart rate source again.
4. BOTH: The monitor displays both the HR and the PR values. The later is displayed at the right of the SPO2 label. The monitor will alarm for both abnormal HR and PR. HR is given priority in determining the source of the beep tone. If HR is not available, the sound will be from the PR.

NOTE

- **If SPO2 is selected from the HR FROM options, the volume of PITCH TONE will be determined by the PR SOUND setting in the SPO2 SETUP menu. If other HR FROM option is selected, the volume of PITCH TONE will be determined by the BEAT VOL (beat volume) setting. For details about PITCH TONE, see *12 SpO2 Monitoring.***

- HR CHANNEL — CH1: The heart rate is determined by the first ECG waveform;
  CH2: The heart rate is determined by the second ECG waveform;
  AUTO: The monitor automatically selects a proper channel to calculate the heart rate.
- LEAD TYPE — Options: 3 LEADS and 5 LEADS;
- SWEEP — Options: 12.5, 25.0 and 50.0 mm/s;
- ST ANALYSIS — For details, see ***11.4 ST Analysis***.
- ARR ANALYSIS — For details, see ***11.5 Arrhythmia Analysis***.

Other Setup

Select OTHER SETUP >> in ECG SETUP menu. The following menu appears.

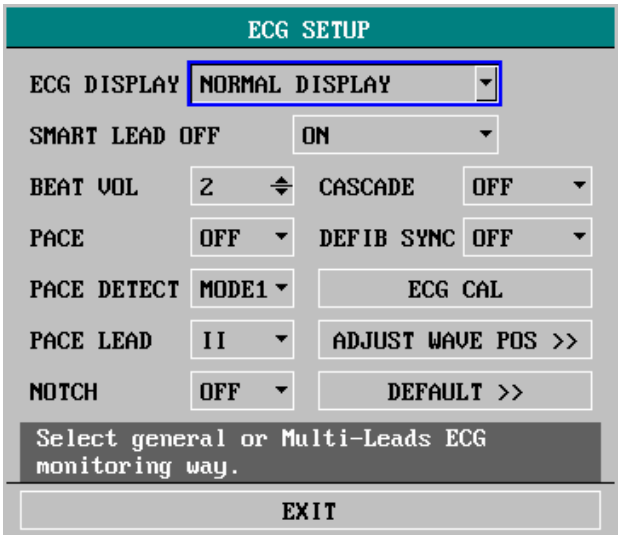


Figure 11-8 Other ECG Setup

In this menu, you can perform the following settings.

- ECG DISPLAY ECG display mode
  Three options are available:

1. NORMAL DISPLAY: The monitor displays two ECG waveforms when the 5-lead set is used or one ECG waveform when the 3-lead set is used.
2. MULTI-LEADS DISPLAY: The monitor displays six ECG waveforms, which occupies the whole waveforms area.
3. HALF-SCN MULTI-LEADS: The monitor displays six ECG waveforms, which only occupies four waveform positions.

NOTE

- **If 3 LEADS is selected from the LEAD TYPE options, only NORMAL DISPLAY can be selected for the ECG DISPLAY.**

- SMART LEAD OFF
  ON: If there is a LEAD OFF in the HR-derived channel, the system will automatically switch to another lead to restore the display of the ECG waveform in the HR-derived channel.
  OFF: The SMART LEAD OFF is turned off.

When ECG is in NORMAL DISPLAY mode, if the SMART LEAD OFF is configured ON and there is a LEAD OFF in the HR-derived channel, the system will automatically switch to another lead to restore the display of the ECG waveform in the HR-derived channel. When the LEAD OFF condition is corrected, the leads are automatically switched back. However, if you manually switch the HR-derived channel, change the ECG display mode, or turn off SMART LEAD OFF before the LEAD OFF condition is corrected, the leas will not be switched back.

Switching rules for SMART LEAD OFF:

LEAD OFF condition	**HR-derived channel automatically switches to**
RA OFF	III
LL OFF	I
LA OFF	II
V OFF	II
RL OFF	None
Any two out of LL, RA and LA fall off.	None
LL, RA or LA, and V fall off together	Same as LL, RA or LA falls off.

NOTE

- **The SMART LEAD OFF function is available only when the LEAD TYPE is 5 LEADS and 12 LEADS.**
- **When the HR CHANNEL is set to AUTO, SMART LEAD OFF does not work as long as there is ECG waveform displayed in either channel 1 or 2.**
- **When you perform ECG calibration, SMART LEAD OFF does not work.**

- BEAT VOL — Beat volume
  Range : 0-10. 0 indicates disabled and 10 indicates the maximum volume.
- PACE — ON: When ON is selected, a detected pacemaker signal is indicated by a "|" symbol above the ECG waveform.
  OFF: When OFF is selected, the pacemaker analysis is disabled.
- PACE DETECT — Pace detection
  Options: MODE1 and MODE2

1. MODE1: In this mode, the function of pacemaker pulse rejection with overshoot is enabled.
2. MODE2: In this mode, the function of pacemaker pulse rejection with overshoot is disabled.

A pacemaker may produce an overshoot signal after the pacemaker pulse, which probably causes false R-wave detection. For this reason, the function of pacemaker pulse rejection with overshoot should be enabled in the calculation. If this function is enabled for a pacemaker without overshoot signals, the R-wave detection might be omitted. Hence, the doctor should choose the PACE DETECT mode carefully according to the pacemaker type.

The PACE DETECT option is active only if PACE is turned ON. When PACE is turned OFF, the PACE DETECT is switched to MODE1 automatically. In this situation, you cannot adjust the PACE DETECT as desired. When PACE is turned ON, you can choose from the PACE DETECT options.

NOTE

- **When monitoring a patient with a pacemaker, PACE must be turned ON. Otherwise, the system will count the pacemaker pulse as QRS complex. Do not completely depend on the alarms of heart rate. The patient with a pacemaker must be nearly monitored.**
- **When PACE is turned ON, the system will neither detect the arrhythmia relating to premature ventricular beats (including PVCs counting) nor perform the ST analysis. When monitoring a patient without a pacemaker, PACE should be turned OFF.**
- **The mode of PACE DETECT cannot be saved after the monitor is turned off or be saved as the factory or the user default configuration. When the monitor is started, restarted or when the factory or user default configuration is selected, PACE DETECT returns to MODE1.**
- **The PACE tag can be printed in the real-time recording when PACE is turned ON.**

■ PACE LEAD Set PACE LEAD as required.

To conduct the 5-lead ECG monitoring, you can select I, II, III, aVR and aVL.

To conduct the 3-lead ECG monitoring, you can select I, II and III.

NOTE

- **You can switch the leads by setting LEAD TYPE in the ECG SETUP menu. At the time of switching between 5 LEADS and 3 LEADS, PACE LEAD in the ECG SETUP menu will be II.**

■ NOTCH Determines whether filter or not.
ON: The monitor protects the signals from the noise generated by the power line.
OFF: No filtering.
During the real-time recording, the NOTCH on/off status and the frequency will be recorded.

NOTE

- **If the filter method of the ECG waveform is set to a non-diagnostic mode, only the NOTCH option ON is active and the monitor filters the signals of the power line frequency; if the filter method is set to the diagnostic mode, two NOTCH options, both ON and OFF, are active, and the system sets the NOTCH to OFF automatically.**

- CASCADE ECG cascade
  ON: The monitor displays the waveform of each channel in two lines.
  OFF: The monitor displays the waveform of each channel in one line.
  The CASCADE can be turned ON only if the monitor is set to NORMAL DISPLAY mode and the SCAN TYPE is set to REFRESH.
- DEFIB SYNC Defibrillator synchronization
  ON: The function of defibrillation is enabled;
  OFF: The function of defibrillation is disabled.

If the function of defibrillator synchronization is enabled and the ventricular defibrillation is applied, 100ms/+5V defibrillator synchronization signals will be output through the auxiliary output connector to the defibrillation equipment.

When the defibrillator synchronization is enabled, the “Defib Sync ON!” message is displayed in the prompt information area, at the lower left corner of the screen. This message disappears after 10 seconds. Besides, the technical alarms area also shows the “DEFIB SYNC ON” message.

NOTE

- **Defibrillator synchronization can be enabled only if the AUX OUTPUT in the USER MAINTAIN menu is set to DEFIB. SYN. Otherwise, this function is disabled.**
- **When the monitor is started, DEFIB SYNC is set to OFF as a default.**

⚠WARNING

- **Improper defibrillation will endanger the patient's safety. You user should decide whether to defibrillate the patient based on the patient's actual condition.**
- **Before defibrillating the patient, the user should ensure the defibrillator and the monitor have been tested as a system and the two devices can work together safely and effectively.**
- **Before defibrillating the patient, the user should ensure the defibrillator has been connected to the auxiliary output port of the monitor, the defibrillation synchronization function is enabled, and the filter mode is set to DIAGNOSTIC.**
- **When the defibrillation is done, sure to disable the defibrillation function and select the filter method as needed.**

- ECG CAL — Select this option to begin calibrating the ECG. To stop calibration, select this option again, or change the ECG lead selection on the screen.
- ADJUST WAVE POS — This is used to adjust the position of the ECG waveform on the screen. Select this option to access the ADJUST WAVE POS menu. Open the CH NAME popup menu and select the channel to be adjusted. Afterwards, select the UP-DOWN option and rotate the control knob to adjust the position of the selected channel on the screen. The BACK TO DEFAULT option allows you to restore the waveform to the default position on the screen.

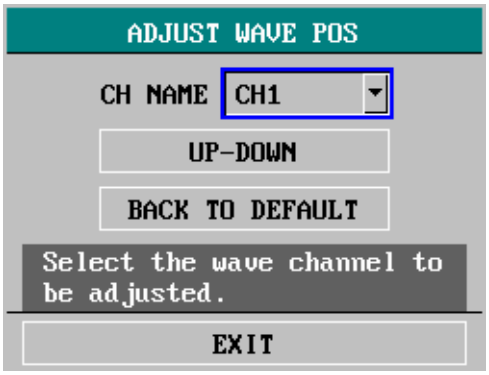


Figure 11-9 ADJUST WAVE POS Menu

- DEFAULT — You can use this option to access the ECG DEFAULT CONFIG menu. You may choose the FACTORY DEFAULT CONFIG or the USER DEFAULT CONFIG. After finishing the selection, a dialog pops up asking for confirmation of your selection.

11.4 ST Analysis

11.4.1 Overview

- The function of ST analysis is optional.
- The ST analysis of the monitor is disabled by default.
- When turning ST ANALYSIS on, the monitor selects DIAGNOSTIC mode automatically. You can set the monitor to MONITOR or SURGERY mode as required. However, the ST numerics might be severely distorted in these modes.
- With the ST analysis, the variance of the ST segment at the waveform tracks of the selected lead can be measured. The ST measurement result is displayed numerically in the ST1 and ST2 positions in the parameter window.
- You can review the ST trend graph and trend data in the TREND GRAPH and the TREND TABLE menus.
- Measurement unit of the ST segment: mV (millivolt).
- Measurement symbols of the ST segment: “+” means positive elevation, “-” means negative elevation.
- Measurement range of the ST segment: -2.0 mV to +2.0 mV.

11.4.2 ST Analysis Menu

Select ST ANALYSIS >> in ECG SETUP menu. The following menu appears.

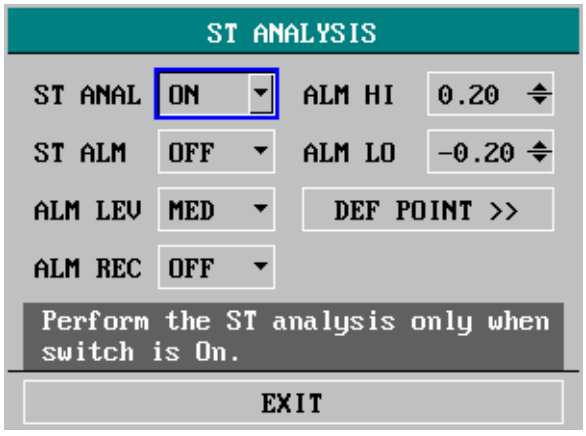


Figure 11-10 ST Analysis

In this menu, you can perform the following settings:

- ST ANAL — ST analysis
  ON: Enables the ST analysis;
  OFF: Disables the ST analysis.

NOTE

- **When turning ST ANALYSIS on, the monitor selects DIAGNOSTIC mode automatically. You can set the monitor to MONITOR or SURGERY mode as required. However, the ST numerics might be severely distorted in these modes.**

- ST ALM — ST segment alarm
  ON: If the measured ST numerics exceed the alarm limit, the monitor gives alarm indications and saves the alarm;
  OFF: If the measured ST numerics exceed the alarm limit, the monitor does not give alarm indications or saves the alarm.
  When OFF is selected, the  icon is displayed on the right of ST1 in the parameter window.
- ST ALM — ST alarm level
  Options: HIGH, MED and LOW;
- ALM REC — ST alarm recording
  ON: The monitor starts recording when an ST alarm occurs;
  OFF: The monitor does not record when an ST alarm occurs.
- ALM HI — Determines the upper limit of the ST alarm; 2.0mV is the highest.
- ALM LO — Determines the lower limit of the ST alarm; -2.0 mV is the lowest.

NOTE

- **The alarm limits for two ST segment numerics are identical. You cannot set the alarm limit of one channel separately.**

ST Measurement Point

Selecting DEF POINT >> opens the following window.

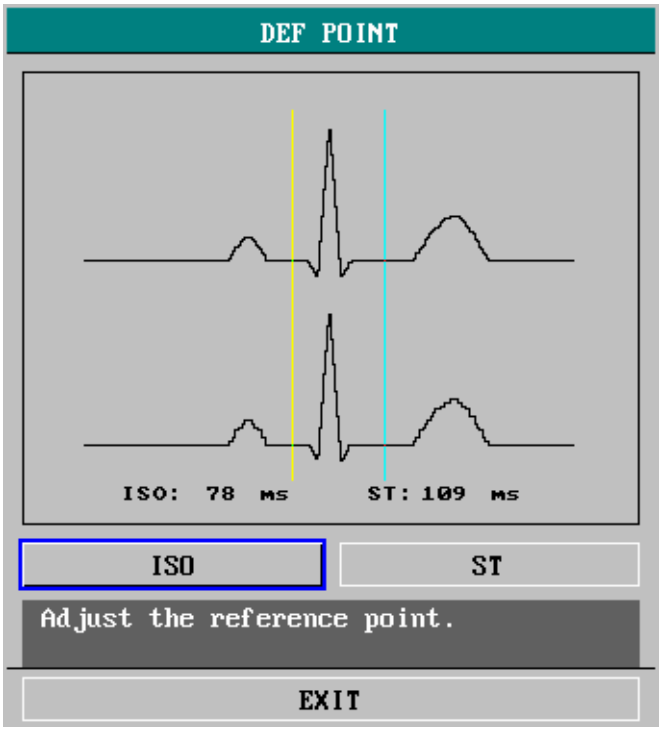


Figure 11-11 ST Measurement Point Setting

As shown above, the DEF POINT window shows the QRS complex template. Two vertical lines indicate the positions of the ISO and ST points.

- ISO: It is the base point, used to indicate the baseline point of the ST analysis. The default is 78ms.
- ST: It is the ST measurement point. The default is 109ms.

The two measurement points, ISO and ST, should be adjusted if the patient's HR or ECG morphology changes significantly. You can select the ISO or the ST option in the window and then rotate the control knob to adjust its position.

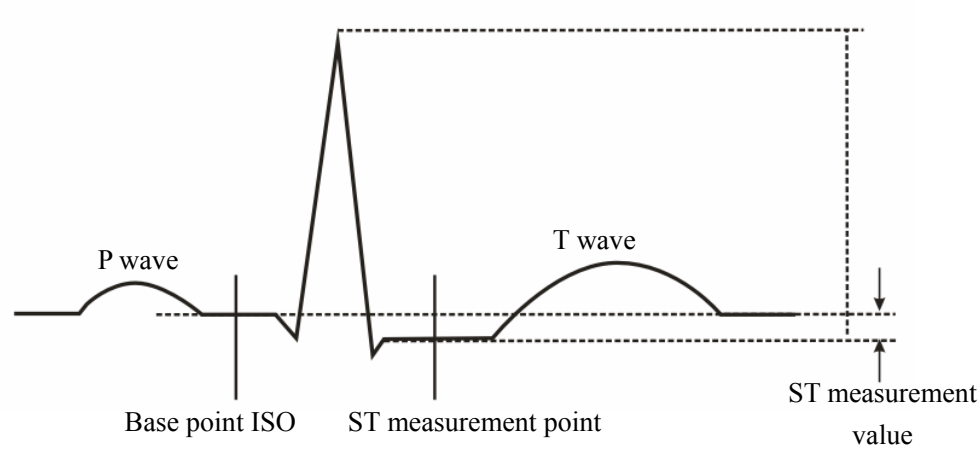


Figure 11-12 ST Measurement Point

As shown above, the peak of the R wave is the reference point for ST measurement. The ST measurement value for a beat complex is equal to the vertical difference between the two measurement points.

NOTE

- **Abnormal QRS complex is not considered in ST analysis.**

11.5 Arrhythmia Analysis

11.5.1 Overview

In clinical application, arrhythmia analysis is used to:

- Monitor the ECG of neonate or adult patients.
- Detect the change of heart rate and premature ventricular beat.
- Store the arrhythmia events and the alarm information generated.

The medical professionals can use the arrhythmia analysis to evaluate patients' condition (such as heart rate, PVCs frequency, rhythm and ectopic beat) and give proper treatment.

The arrhythmia analysis of the monitor has the following characteristics:

- Up to 13 types of arrhythmia analysis.
- Applicable to the monitoring of either a patient with a pacemaker or without.
- Disabled in default situation.
- Capability of raising the doctor's attention to the patient's heart rate, by measuring and classifying the arrhythmia and the abnormal heartbeat and triggering the alarm.
- Capability of storing the latest 80 alarm events (including the ECG waveform respectively 4 seconds before and after the alarm), when performing the arrhythmia analysis. You can review the arrhythmia events through the menu below.

11.5.2 Arrhythmia Analysis Menu

Select ARR ANALYSIS >> in ECG SETUP menu. The following menu appears.

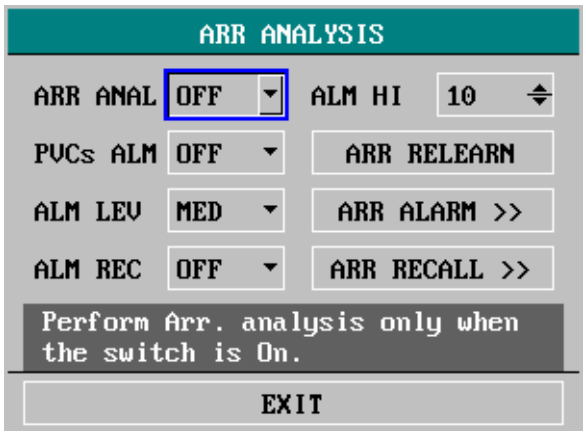


Figure 11-13 Arrhythmia Analysis

In this menu, you can perform the following settings:

- ARR ANAL — Arrhythmia analysis
  ON: Enables the arrhythmia analysis;
  OFF: Disables the arrhythmia analysis.
- PVCs ALM — PVCs alarm
  ON: When the PVCs alarm occurs, the monitor gives alarm indications and saves the alarm;
  OFF: When the PVCs alarm occurs, the monitor neither gives alarm indications nor saves the alarm;
  When OFF is selected, the icon is displayed on the right of PVCs in the parameter window.
- ALM LEV — Alarm level
  Options: HIGH, MED and LOW.
- ALM REC — Alarm recording
  ON: The monitor starts recording when the PVCs alarm occurs.
  OFF: The monitor does not record when the PVCs alarm occurs.
- ALM HI — Upper alarm limit
  Determines the upper limit of the PVCs alarm. Range: 1 – 10. An alarm is triggered when the PVCs exceeds the upper limit.
- ARR RELEARN — Arrhythmia relearning
  You can select this option to start a learning procedure. The "ARR LEARNING" message is displayed in the information area of the screen.

11.5.3 Arrhythmia Alarm Setup

Select ARR ALARM >> in ECG SETUP menu. The following menu appears. You can change the settings of the arrhythmia alarm in this menu.

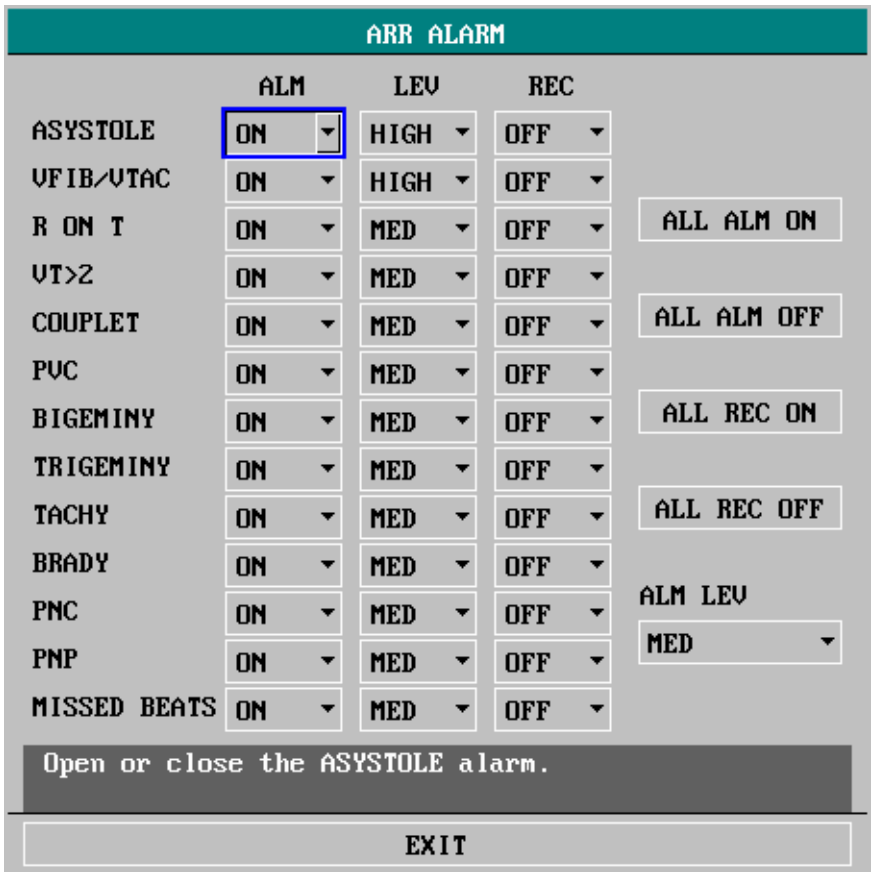


Figure 11-14 Arrhythmia Alarm Setup

In the menu, the ALM field indicates the alarm on/off status, REC indicates the alarm recording on/off status and LEV indicates the alarm level. You can change the settings as described below.

- ALL ALM ON — All alarms on
  Enables all arrhythmia alarms;
- ALL ALM OFF — All alarms off
  Disables all arrhythmia alarms;
- ALL REC ON — All recording on
  Enables the recording of all arrhythmia alarms;
- ALL REC OFF — All recording off
  Disables the recording of all arrhythmia alarms;
- ALM LEV — Options: HIGH, MED and LOW.
  Sets the level of all arrhythmia alarms to the same value.

11.5.4 Arrhythmia Recall

Selecte ARR RECALL >> in ARR ANALYSIS menu. The following menu appears. You can review any stored arrhythmia event in this menu.

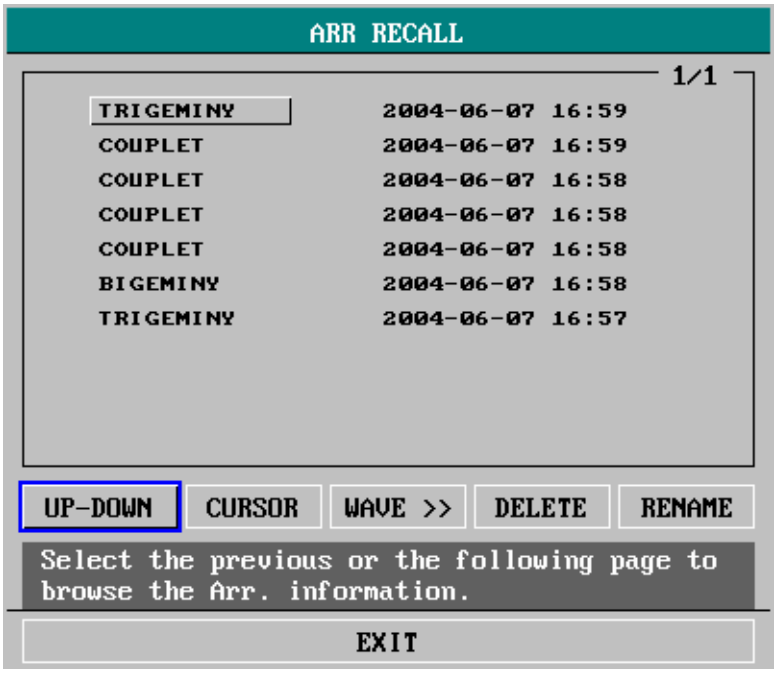


Figure 11-15 Arrhythmia Recall

You can perform the following operations:

- UP-DOWN — A maximum of 10 arrhythmia events can be displayed in the window each time. In case of more than 10 events, you can use the UP-DOWN option to review more. At most 8 pages can be reviewed.
- CURSOR — This option allows you to select an arrhythmia event displayed in the window.
- DELETE — This option allows you to delete a selected arrhythmia event.
- RENAME — This option allows you to change the name of a selected arrhythmia event.
  Select this option, and rotate the control knob till the desired name appears. Then, press the control knob to select the name.
- WAVE >> — Selecting this option opens the following window. In the window, the waveform and the time of a selected arrhythmia event as well as the parameter values at the event time are displayed.

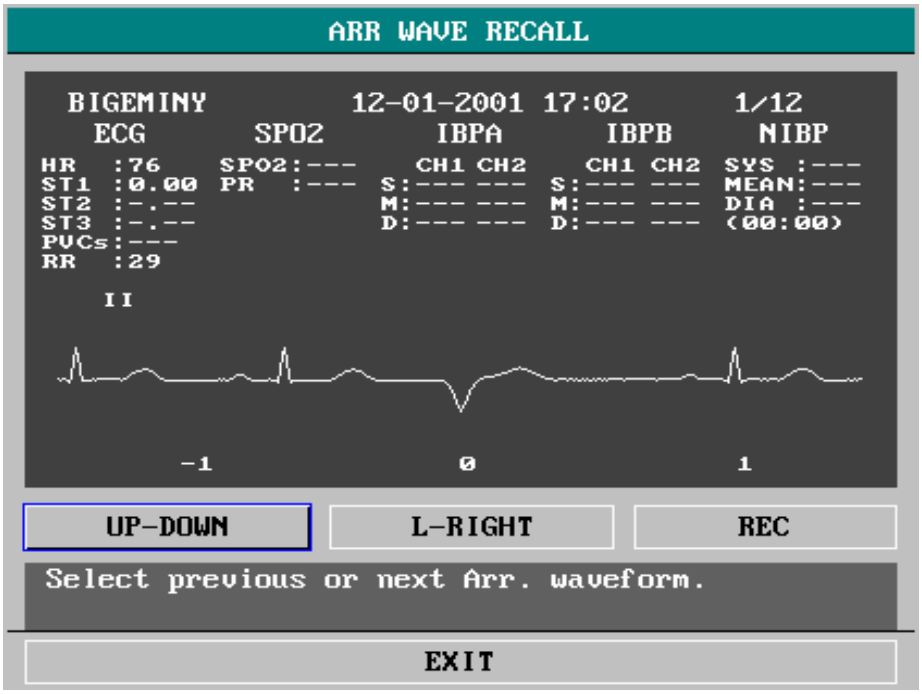


Figure 11-16 Arrhythmia waveform Review

You can perform the following operations:

- UP-DOWN — This option allows you to page up and down to review the waveform and the parameters of other arrhythmia events.
- L-RIGHT — This option allows you to review 8-second waveform of the currently displayed arrhythmia event.
- REC — Selecting this option starts the recording of the waveform and the parameters of the currently displayed arrhythmia event.
- EXIT — This option allows you to return to the ARR RECALL window.

11.6 ECG 12-Lead Monitoring

11.6.1 General

ECG Waveform

In the 12-lead monitoring process, two channels of waveforms are displayed in the waveform area. See ***11.1.1 ECG Waveform***. Optional leads for Channel 1 and Channel 2 include: I, II, III, aVR, aVL, aVF and V, among which V refers to the waveform of the V1 lead. To view the waveform of any other Vx lead at the time of 12-lead monitoring, you only need to place the V1 electrode to the required position.

ECG Parameter



Figure 11-17 ECG parameters

ECG parameters are displayed to the right of the ECG waveforms. See the figure above. The heartbeat indicator is displayed and flashes at the frequency of the patient's heartbeat. To the right of the HR numeric are the status or numerics of PACE, ST, PVCs and NOTCH. When the ST analysis function is set to ON, the ST status will not be displayed here, but the ST data area will appear in the parameter area. See the following figure.


ST label
ST numerics
ST ANT INF LAT
V1 0.00 II 0.00 I 0.00
V2 0.00 III 0.00 aVL 0.00
V3 0.00 aVF 0.00 V5 0.00
V4 0.00 aVR 0.00 V6 0.00
ST Alarm Disabled icon

Figure 11-18 ST data area

In the ST data area, if you select the ST label, the ST Setup menu will appear. For details, refer to ***11.6.3 ECG Setup Menu for 12-Lead Monitoring***: ***ST Analysis.*** Besides, this area displays the ST numerics of all leads.

Lead group: ANT (Anterior), LAT (Lateral,) and INF (Inferior). The group names are displayed above the parameters. Leads that are related to each group are:

- ANT: V1, V2, V3 and V4

- INF: II, III, aVF and aVR
- LAT: I, aVL, V5 and V6

Each ST group corresponds to an alarm limit. Once there is a parameter exceeding the alarm limit of the group to which the ST parameter belongs, the alarm will be triggered and the name of the group will flash.

At the time of 12-lead monitoring, when you enter the large-font screen, the parameter area will be displayed as shown below.

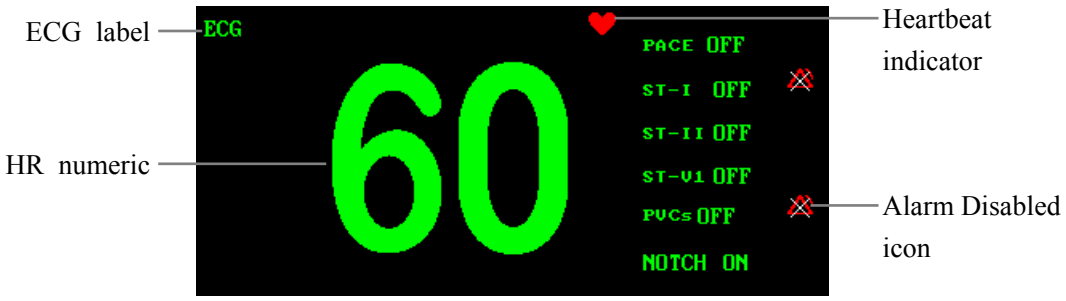


Figure 11-19 ECG parameters on large-font screen

The heartbeat indicator is displayed and flashes at the frequency of the patient's heartbeat. To the right of the HR numeric are the status or numerics of PACE, 3 groups of ST, PVCs and NOTCH.

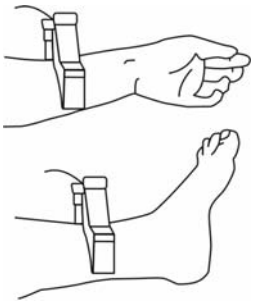
11.6.2 Monitoring Procedure

For the preparation for the electrode placement, refer to ***11.2 ECG Monitoring Procedure***.

Installing the electrodes

With reference to the American standard, the electrodes of the 10-leadwire ECG cable shall be placed as follows for the 12-lead analysis:

- RA (right arm) electrode;
- LA (left arm) electrode;
- RL (right leg) electrode;
- LL (left leg) electrode;
- Attach the four limb electrodes to the soft skin of the hands/legs.



Attach the chest (V) electrodes to the following positions:

- V1: On the 4th intercostal space at the right sterna margin;

- V2: On the 4th intercostal space at the left sterna margin;
- V3: Midway between V2 and V4 electrodes;
- V4: On the 5th intercostal space at the left clavicular line;
- V5: On the left anterior axillary line, horizontal with V4 electrode;
- V6: On the left middle axillary line, horizontal with V4 electrode;

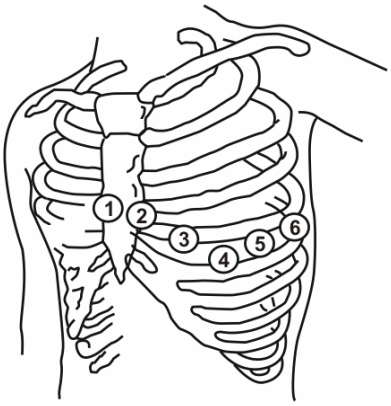


Figure 11-20 Positions of Chest Electrode

NOTE

- **The conductive ointment coatings should be isolated, and the chest electrodes should have no contact with each other to avoid short-circuit.**
- **Do not use the physiological saline, which erodes the electrodes, instead of the electrode gel.**
- **Using 3M electrodes is recommended during defibrillation.**

The chart below shows the label used to identify each leadwire. Included also is its associated color code per American (AHA) and European (IEC) standards.

American Standard		**European Standard**	
Label	Color	Label	Color
RA	White	R	Red
LA	Black	L	Yellow
LL	Red	F	Green
RL	Green	N	Black
V	Brown	C	White

Connections of leadwires

I, II, and III are the standard leads, aVR, aVL and aVF are monopolar augmented limb leads, and Vx (x corresponds to any of 1, 2, 3, 4, 5 and 6.) is the monopolar chest lead. Together, these leadwires structure the 12-lead connection.

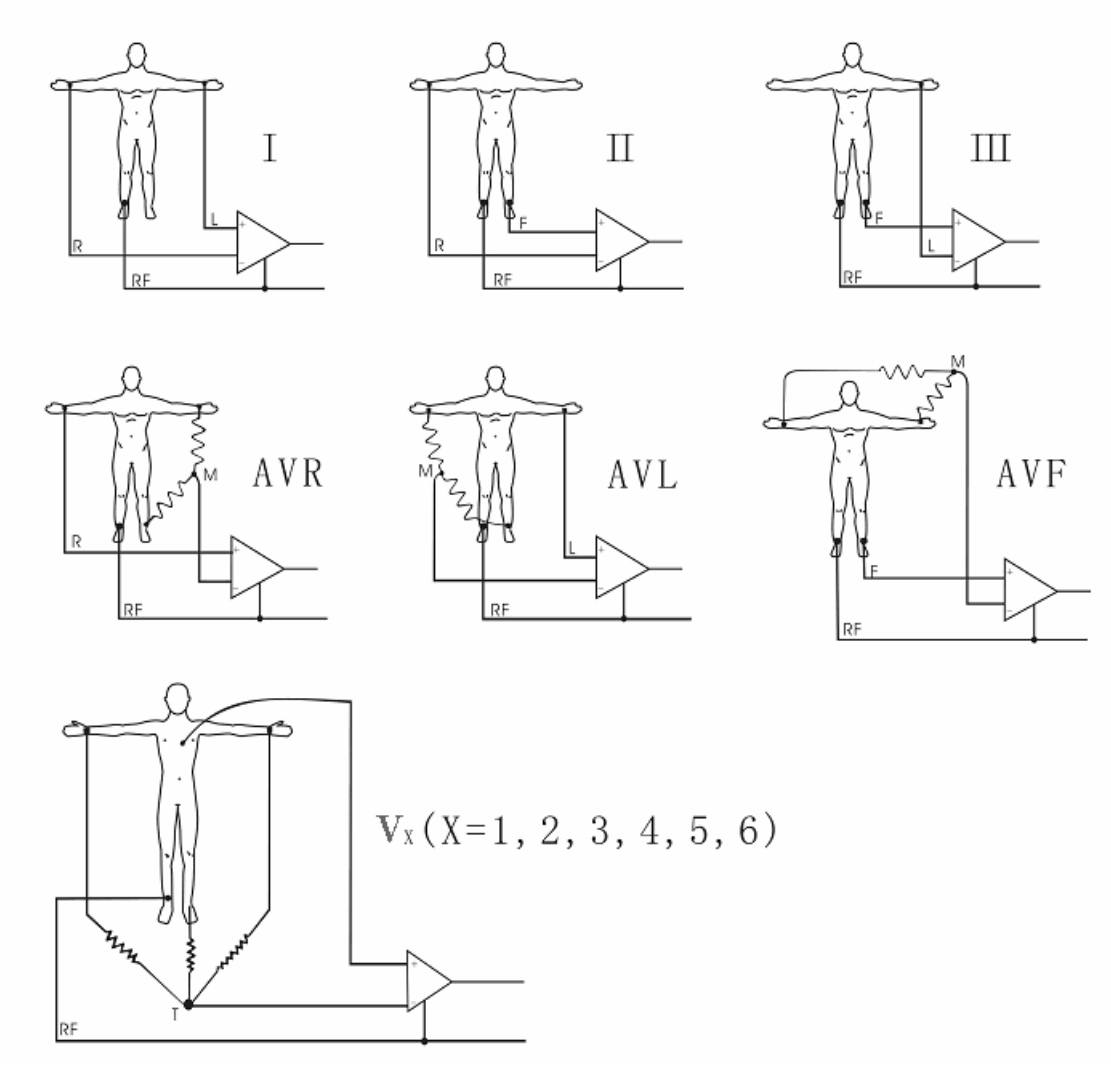


Figure 11-21 12-lead connection methods

11.6.3 ECG Setup Menu for 12-Lead Monitoring

Select the ECG label in the parameter windows. The following menu appears.

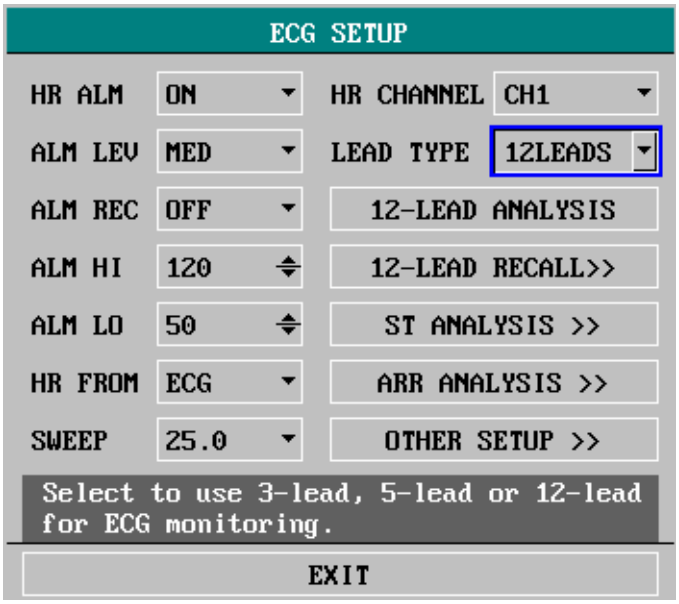


Figure 11-22 ECG Setup Menu

This menu contains ECG setup items and sub-menus. For details, refer to ***11.3 ECG Setup Menu***. In this menu, you can set LEAD TYPE to any of 3 LEADS, 5 LEADS and 12 LEADS.

Select OTHER SETUP >> in the ECG SETUP menu shown above. The following menu appears.

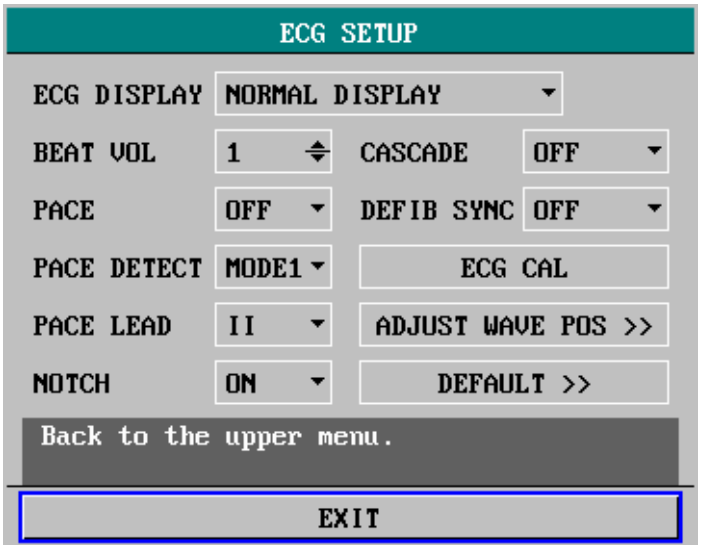


Figure 11-23 Other ECG Setup

For details about this menu, refer to ***11.3 ECG Setup Menu, Other Setup***.
To conduct the 12-lead ECG monitoring, you can set PACE LEAD as I, II, III, aVR, aVL, V1, V2, V3, V4, V5 and V6.

NOTE

- **You can switch the leads by setting LEAD TYPE in the ECG SETUP menu. At the time of switching between 12 LEADS, 5 LEADS and 3 LEADS, PACE LEAD in the ECG SETUP menu will be II.**
- **When you select the 12-lead analysis screen, the rhythm lead waveform and the selected PACE lead waveform will be marked with PACE indicator, but other lead waveforms will not be marked with the PACE indicator.**

The 12-lead ECG monitoring functions and other sub-menus are elaborated in the following sections.

Entering the 12-lead ECG monitoring screen

In ECG SETUP menu, set LEAD TYPE to 12 LEADS to enter the 12-lead monitoring. Consequently, 12-LEAD ANALYSIS and 12-LEAD REVIEW buttons below the LEAD TYPE will be enabled.

12-lead analysis

In ECG SETUP menu, select 12-LEAD ANALYSIS to enter 12-lead analysis screen, as shown in Figure 11-24.

The 12-lead analysis screen is also divided into the waveform area and parameter area. In the parameter area on the right of the screen, the monitor displays 5 parameters: ECG, SPO2, NIBP, RESP and TEMP. In the waveform area on the left of the screen, the monitor displays all waveforms (namely, 12 ECG waveforms and a rhythm waveform) as default.

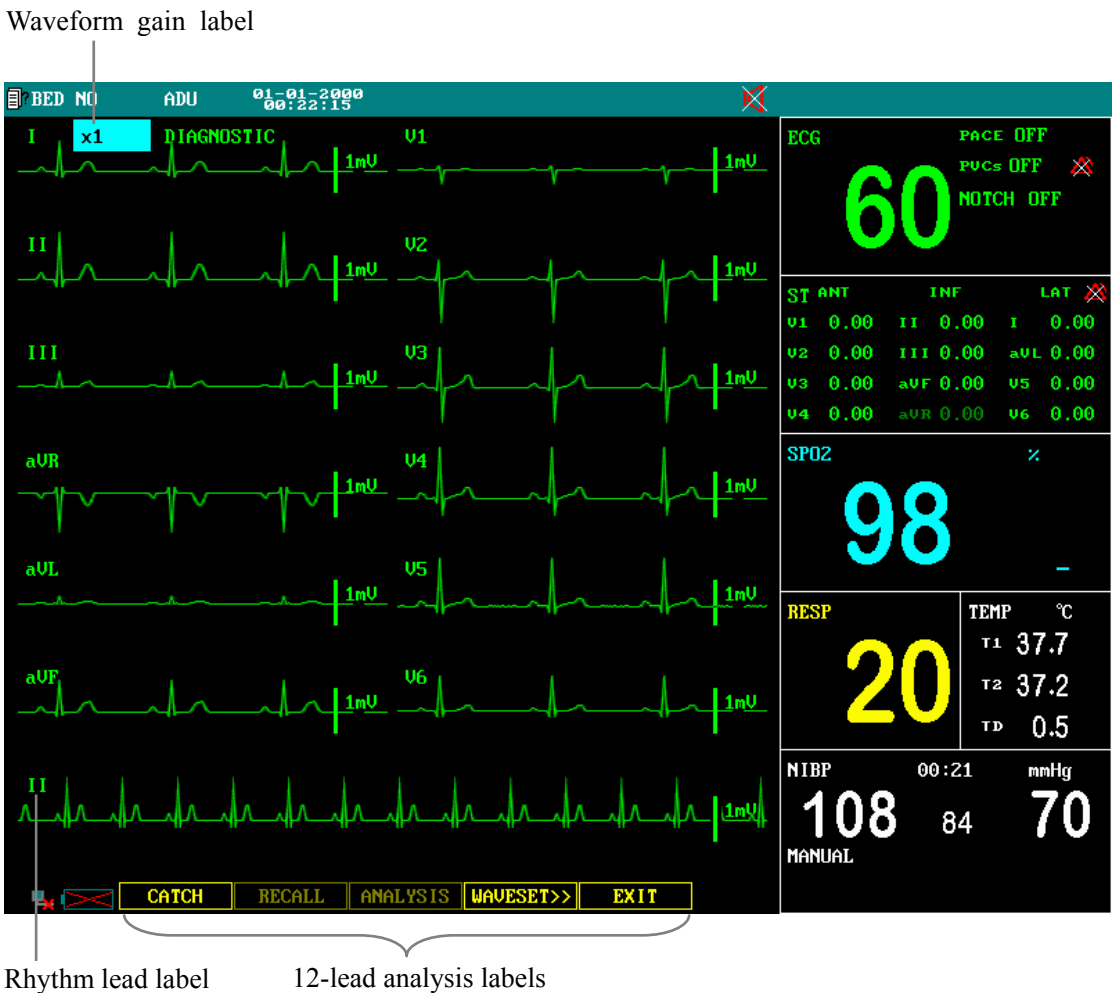


Figure 11-24 ECG 12-lead analysis screen

NOTE

- **In the 12-lead analysis mode, the monitor cannot be set to the standby mode and the LEAD TYPE option in the ECG SETUP menu is disabled.**
- **In the 12-lead analysis mode, the system will automatically disable the DEFIB. SYNC. function.**
- **On the 12-lead analysis screen, FILTER is DIAGNOSTIC, which cannot be set by the user.**
- **In the 12-lead analysis mode, the setting of HR CHANNEL is the same in the normal monitoring screen. But here, the CH1 of HR CHANNEL setting corresponds to II lead immovably, and the CH2 corresponds to I lead immovably.**

In the waveform area, there are also 7 labels: waveform gain label, rhythm lead label and 5 12-lead analysis labels.

- GAIN — Used to adjust the amplitudes of ECG waveforms for all leads. Option: ×0.125, ×0.25, ×0.5, ×1, ×2, AUTO

  If GAIN is set to AUTO, the gain will be adjusted by the monitor automatically. Each waveform is followed by a 1mV scaling line, the height of which is proportional to the amplitude of the waveform.

- RHYTHM — Used to select the name of the rhythm lead. Option: I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5 and V6.

- CATCH — When the waveform is long enough, you can select this label to freeze all waveforms except the rhythm lead waveform, and this label changes to RELEASE; Press it again, the frozen waveforms will be unfrozen, and this label becomes CATCH again.

  When the waveforms are not long enough, if you select this label, a dialog box will appear prompting that the analysis cannot be done due to the inadequate data.

- RECALL — When the waveforms are frozen, you can select this label and rotate the control knob clockwise or counterclockwise to review the waveforms.

- ANALYSIS — When the waveforms are frozen, you can select this label to perform the 12-lead analysis. During the analysis, the monitor does not respond to any operation. At the end of the analysis, the analysis result will be displayed on the screen.

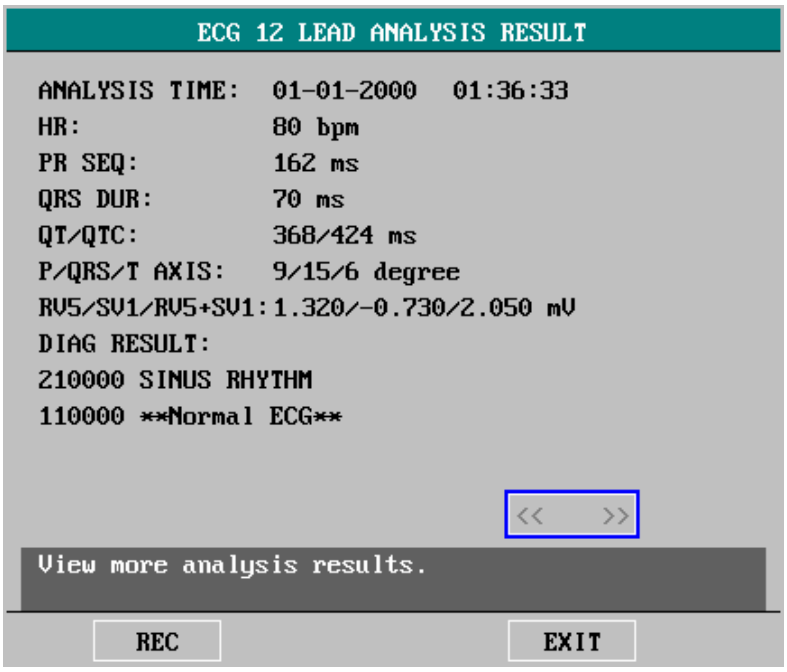


Figure 11-25 ECG 12-lead analysis result

You can print the analysis result by selecting the REC button in the ECG 12 LEAD ANALYSIS RESULT.

- WAVESET>> You can select this label to enter the 12 LEAD WAVE menu, and then select the required waveset. The rhythm lead waveform will always be displayed at the bottom in spite of the set mode.

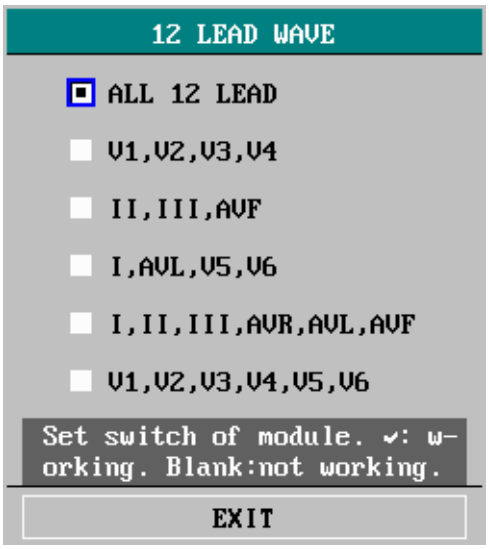


Figure 11-26 ECG 12-lead waveform setup

- EXIT You can select this label to exit the 12-lead analysis screen.

NOTE

- **In the 12-lead analysis screen, labels except the ECG-related ones (ECG, ST, GAIN, RHYTHM, CATCH, RECALL, ANALYSIS, WAVESET>>, EXIT) are all disabled.**
- **The FREEZE and REC buttons on the control panel are invalid for the 12-lead analysis screen.**
- **In the 12-lead analysis screen, you can press the MAIN and MENU buttons on the control panel to exit the 12-lead analysis screen and return to the normal monitoring screen.**
- **A maximum of 8 12-lead ECG analysis results are generated for each time.**

ST Analysis

Select the ST label in the parameter area, or select ST ANALYSIS >> in ECG SETUP menu. The following menu appears.

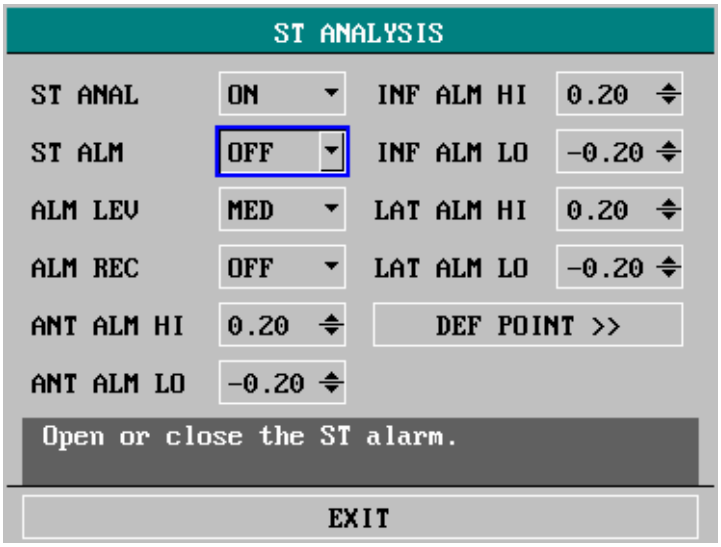


Figure 11-27 ST ANALYSIS menu

In the ST ANALYSIS menu, you can perform the following settings:

ST ANAL ST analysis

ON: Enables the ST analysis;

OFF: Disables the ST analysis.

NOTE

- **When ST ANAL is set to ON, the monitor selects DIAGNOSTIC mode automatically. You can set the monitor to MONITOR or SURGERY mode as required. However, the ST numerics might be severely distorted in these modes.**

■ ST ALM ST segment alarm

ON: If the measured ST numerics exceed the alarm limit, the monitor gives alarm indications and saves the alarm;
OFF: If the measured ST numerics exceed the alarm limit, the monitor does not give alarm indications or save the alarm.

When OFF is selected, the icon is displayed on the upper right of the ST data area.

■ ALM LEV ST alarm level

Options: HIGH, MED and LOW;

- ALM REC — ST alarm recording
  ON: The monitor starts recording when an ST alarm occurs;
  OFF: The monitor does not record when an ST alarm occurs.
- ANT ALM HI — Determines the upper limit of the ST alarm in the ANT group; 2.0mV is the highest.
- ANT ALM LO — Determines the lower limit of the ST alarm in the ANT group; -2.0 mV is the lowest.
- INF ALM HI — Determines the upper limit of the ST alarm in the INF group; 2.0mV is the highest.
- INF ALM LO — Determines the lower limit of the ST alarm in the INF group; -2.0 mV is the lowest.
- LAT ALM HI — Determines the upper limit of the ST alarm in the LAT group; 2.0mV is the highest.
- LAT ALM LO — Determines the lower limit of the ST alarm in the LAT group; -2.0 mV is the lowest.

12-lead review

Select 12 LEAD RECALL >> In ECG SETUP menu. The following menu appears.

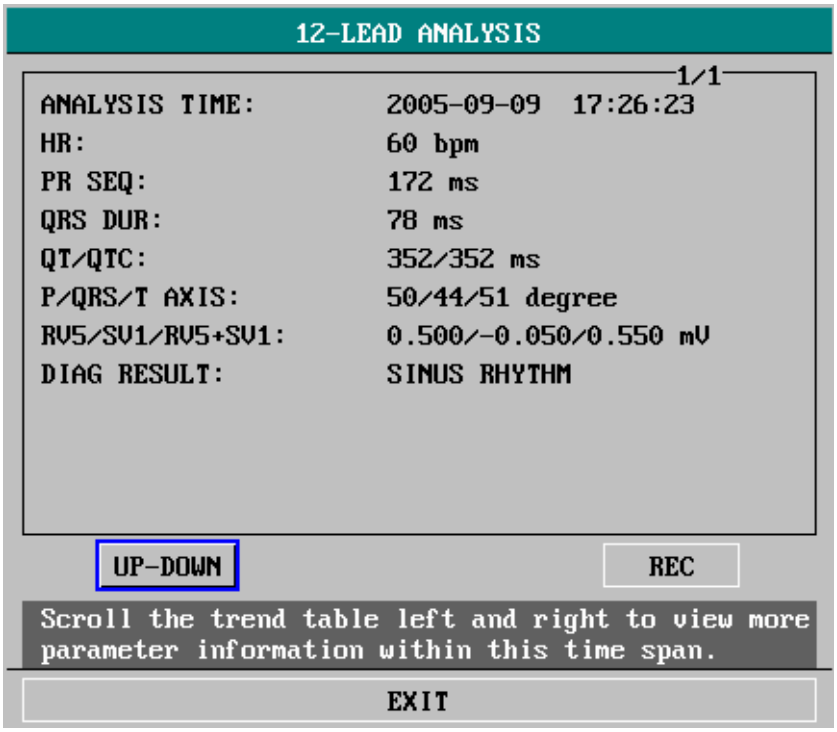


Figure 11-28 12-lead review

In this menu, you can recall 80 12-lead analysis results. When the number of 12-lead results exceeds 80, the earliest results will be deleted.

11.6.4 Data Review

If 12-lead monitoring is performed within the latest reviewable 96hr, you can review the 12-lead trend data in the TRAND GRAPH and TREND TABLE window.

Trend graph

In SYSTEM MENU, select TREND GRAPH >>. The TREND GRAPH window appears. For details about the trend graph, refer to ***9.2 Trend Graph Recall***.

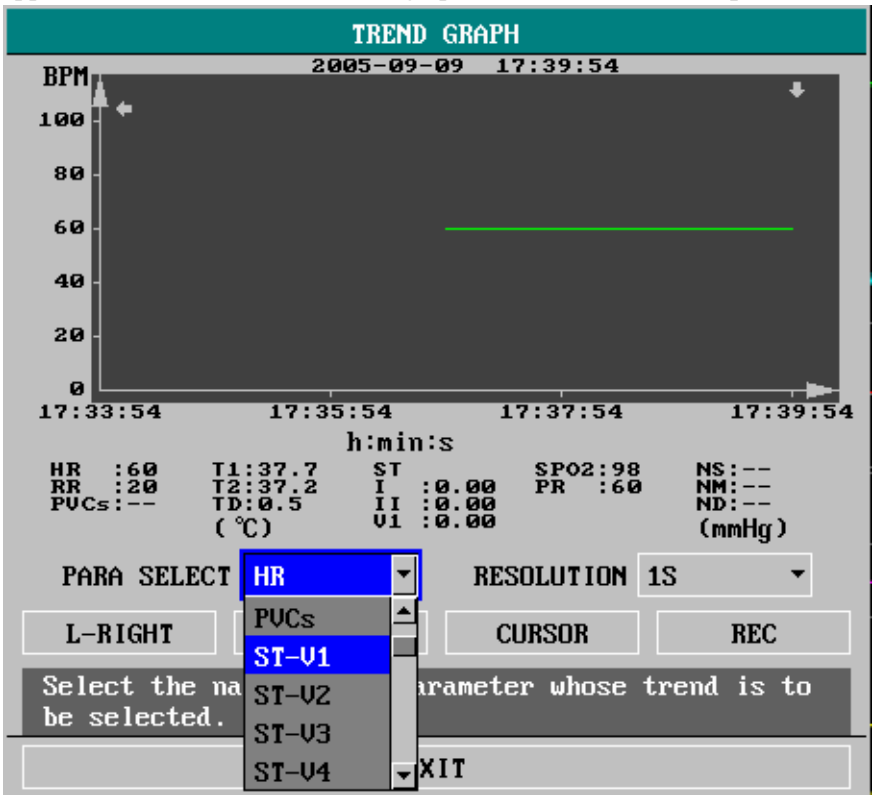


Figure 11-29 Trend graph

In the 12-lead monitoring process, each ST numeric has a trend graph. In TREND GRAPH window, when you select a ST parameter from PARA SELECT drop-down list box; all ST numerics of its group will be displayed. If you select parameters other than ST, only 3 ST numerics (I, II and V1) will be displayed.

Trend table

In SYSTEM MENU, select TREND TABLE >>. The TREND TABLE window appears. For details about the trend table, refer to ***9.3 Trend Table Recall***.

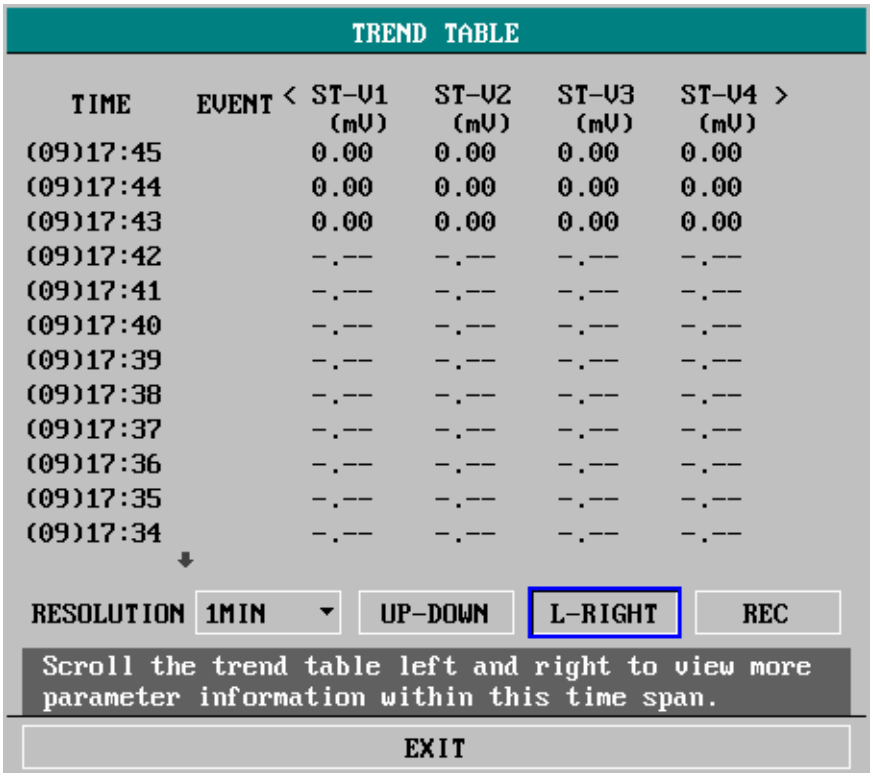


Figure 11-30 Trend table

You can review the ST parameters of the 12-lead monitoring. Through the L-RIGHT button, 3 groups of ST numerics can be displayed.

ARR review

For details about the ARR review, refer to ***11.5.4 Arrhythmia Recall***.
For the ARR review in the 12-lead monitoring, the ST parameters displayed in the review screen are ST-I, ST-II and ST-V1, and the displayed waveforms are the waveforms of the first two ECG channels.

Alarm event review

For details about the alarm event review, refer to ***9.5 Alarm Event Recall***.
For the alarm event review in the 12-lead monitoring:

- In case of an ST alarm, the ST parameters displayed in the review screen are all ST numerics in it's group, and the waveforms are those of ECG Channel 1 and of the alarmed lead; if the two waveforms are the same, the waveform of ECG channel 2 will be displayed.
- In case of an HR alarm, the ST parameters displayed in the review screen are ST-I, ST-II and ST-V1, and the displayed waveforms are the waveforms of the first two ECG channels.

11.7 RESP Monitoring

11.7.1 Overview

Respiration is detected by measuring thoracic impedance. The monitor measures the change of the impedanec between the RA and LA electrodes of the ECG lead I, or the RA and LL electrodes of the ECG lead II, and produces a respiration waveform as shown below.

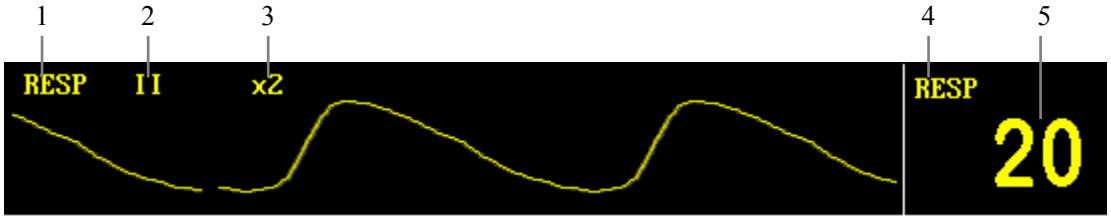


Figure 11-31 Respiration Waveform and Parameter

1. Waveform name.
2. RESP lead: I or II
3. Waveform gain: 7 options are available: ×0.25, ×0.5, ×1, ×2, ×3, ×4, ×5. If the gain is too large, the upper part of the waveform may not be normally displayed.
4. RESP label: Selecting this label, you can open the RESP SETUP menu.
5. RR: Respiration rate numerics.

NOTE

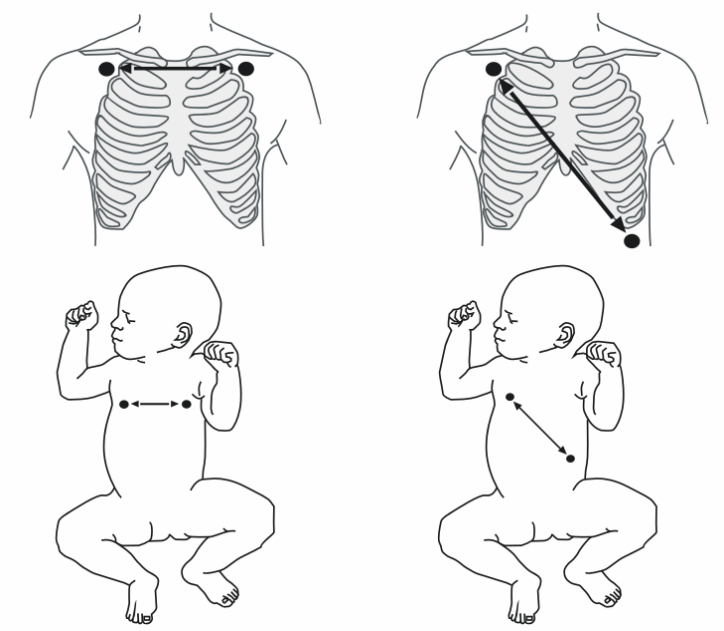
- **Respiration monitoring is not recommended on patients who are very active, as this will cause false alarms.**
- **It is recommended to set Waveform gain to 1 when external electromagnetic interference is great.**

11.7.2 Electrode Placement

Since the same electrodes are used for ECG and respiration monitoring, the electrode placement is very important. Some patients, due to their clinical condition, expand their chest laterally, causing a negative intrathoracic pressure. In these cases it is better to place the two electrodes used for respiration monitoring laterally in the right axillary and left lateral chest areas, at the maximum point of the breathing movement, to optimize the respiratory waveform.

NOTE

- **Please select the ECG cable with no resistance for RESP monitoring.**
- **To optimize the respiration waveform, place the RA and LA electrodes horizontally when the ECG Lead I is selected, and place the RA and LL electrodes diagonally when the ECG lead II is selected.**
- **Try to avoid placing the electrodes so the liver area and the ventricles of the heart are in path between the electrodes used for respiration, to avoid cardiac artifact to overlay on the ECG. This is particularly important when monitoring neonate patients.**



Electrode Placement of ECG Lead I Electrode Placement of ECG Lead II

Figure 11-32 Electrode Placement

11.7.3 Respiration Setup

Selecting the RESP label on the screen opens the following menu.

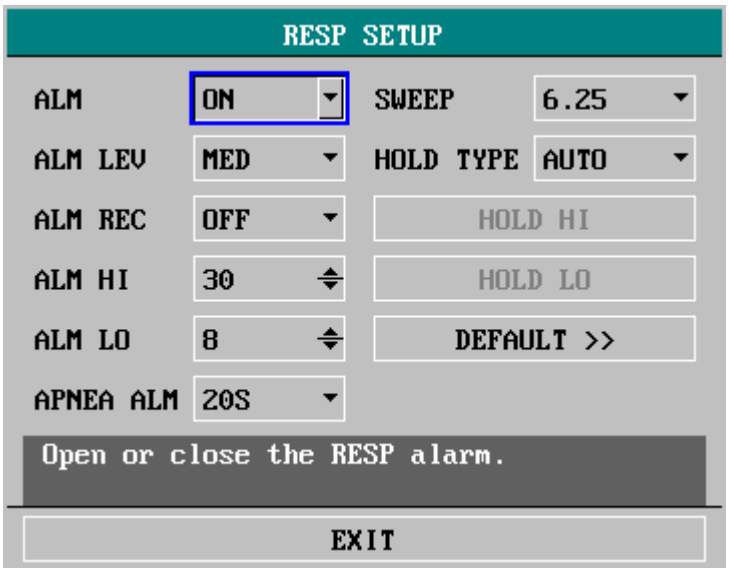


Figure 11-33 RESP Setup Menu

In this menu, you can perform the following settings.

- ALM — Alarm on/off
  ON: When a respiration rate alarm occurs, the monitor gives alarm indications and stores the alarm;
  OFF: When a respiration rate alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
  When OFF is selected, the icon is displayed on the right of the RESP label.
- ALM LEV — Alarm level
  Options: HIGH, MED and LOW.
- ALM REC — Alarm recording
  ON: When a respiration rate alarm occurs, the monitor enables the recording;
  OFF: When a respiration rate alarm occurs, the monitor does not enable the recording
- ALM HI — Upper alarm limit
  Determines the upper limit of respiration rate alarm.
- ALM LO — Lower alarm limit
  Determines the lower limit of respiration rate alarm.

For different patient types, the upper/lower limits of the respiration rate alarm may vary in the following range.

Patient type	Max. ALM HI	Min. ALM LO	Increment
Adult	120	0	1
Neonate/pediatric	150	0	1

- APNEA ALM — Apnea alarm
  Determines whether the patient's cessation of breath is an apnea event. Range: 10 – 40 seconds.
- SWEEP — Waveform speed
  Options: 6.25, 12.5 and 25.0 mm/s.
- HOLD TYPE — Calculation type
  Options: AUTO and MANUAL

1. AUTO: When AUTO is selected, the monitor automatically determines the detection threshold for respiration and calculates the respiration rate. The HOLD HI and HOLD LO options are inactive.
2. MANUAL: When MANUAL is selected, the user determines the detection threshold for respiration and the monitor calculates the respiration rate depending on the user-selected criteria.

- DEFAULT >> — Select DEFAULT >> to access the RESP DEFAULT CONFIG menu. You can select either FACTORY DEFAULT CONF or USER DEFAULT CONF. After finishing the selection and exiting the menu, a dialog pops up asking for confirmation of your selection.

11.8 Maintenance and Cleaning

⚠WARNING

- **Before cleaning the ECG cable, be sure to disconnect the monitor from the ECG cable, or shut down the system and disconnect all power cords from the outlet.**
- **If the ECG cable is damaged or aged, replace with a new one.**

■ Cleaning

The exterior surfaces of the ECG cable may be cleaned with a soft cloth, dampened with the alcohol, and then be air-dried or dried with a clean dry cloth.

■ Disinfection

Disinfection may cause damage to the equipment. We recommend the disinfection be contained in the hospital's servicing schedule only when necessary. The equipment should be cleaned prior to disinfection.

■ Sterilization

Sterilization may cause damage to the equipment. We recommend the sterilization be contained in the hospital's servicing schedule only when necessary. The equipment should be cleaned prior to sterilization.

FOR YOUR NOTES

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12.1 Overview

The monitor measures the patients' SpO_2 (oxygen saturation) and displays:

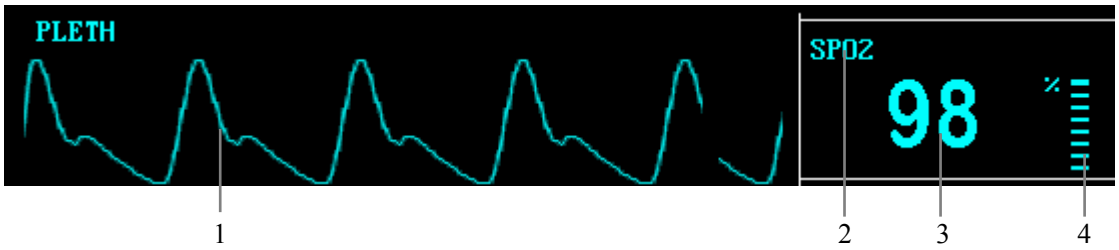
1. Pulse rate (PR) value in the ECG or SpO_2 parameter window.
2. PLETH waveform in the waveforms area.
3. Oxygen saturation (SpO_2%) value in the SpO_2 parameter window.

The PR value is displayed in the ECG parameter window only if:

1. SpO_2 is selected from the HR FROM options in the ECG SETUP menu; or
2. AUTO is selected from the HR FROM options in the ECG SETUP menu and no ECG signal is received.

For details, see ***11.3 ECG Setup Menu***.

As the following figure shows, the PLETH waveform is located on the left while the SpO_2 parameter window on the right. The SpO_2 value is displayed by percentage and is followed by a perfusion indicator (pro rata with the pulse intensity). Besides, the SpO_2 label at the upper left corner of the parameter window allows you to access the SpO_2 SETUP menu.



1. PLETH waveform
2. SPO2 label
3. SpO_2 value
4. Perfusion indicator

Figure 12-1 SpO_2 Waveform and Parameter

PITCH TONE

The PITCH TONE function refers to the monitor's capability to vary the pitch of the heart rate tone or pulse rate tone with the change of the SpO_2 reading. This monitor provides 22 pitch levels. The pitch rises as the SpO_2 reading increases toward 100% and falls as it decreases. Although the tone pitch cannot be adjusted manually, the tone volume can be adjusted by one of the following two ways, depending on the setting of the HR FROM item in the ECG SETUP menu:

- If the HR FROM is set to SPO2, you can adjust the PITCH TONE volume by

changing the setting of the PR SOUND item in the SPO2 SETUP menu;

- In case of other settings, you can adjust the PITCH TONE volume by changing the setting of the BEAT VOL item in the ECG SETUP menu.

If the PR SOUND or BEAT VOL is set to 0, the PITCH TONE function will be muted; if the SpO_2 module is disabled, the PITCH TONE function will be disabled as well.

This monitor can be equipped with any of the following SpO_2 modules:

- Mindray SpO_2 module
- Masimo SpO_2 module
- Nellcor SpO_2 module

A monitor, equipped with a Masimo or Nellcor SpO_2 module, is marked by "Masimo" or "Nellcor" at the lower left corner of the front panel. The following pages respectively gives introduction to the above three SpO_2 modules. Please read according to your monitor configuration before operation.

NOTE

- **SpO_2 and SPO2 are used interchangeably in this chapter.**

12.2 Mindray SpO_2 Module

NOTE

- **This section is only applicable to the monitor equipped with a Mindray SpO_2 module.**

12.2.1 Principles of Operation

SpO_2 monitoring is a non-invasive technique used to measure the amount of oxygenated haemoglobin and pulse rate by measuring the absorption of selected wavelengths of light. The light generated in the probe passes through the tissue and is converted into electrical signals by the photodetector in the probe. The SpO_2 module processes the electrical signal and displays on the screen a waveform and digital values for SpO_2 and pulse rate.

The sensor measurement wavelengths are nominally 660nm for the red LED and 940nm for infrared LED. The maximum optical power output for LED is 4mW.

12.2.2 Precautions

⚠WARNING

- **The SpO_2 value might be overestimated in the presence of Hb-CO, Met-Hb or dye dilution chemicals.**
- **Check if the sensor cable is in normal condition before monitoring. Do not use the SpO_2 sensor once the package or the sensor is found damaged.**
- **Verify sensor cable fault detection before beginning monitoring. Unplug the SpO_2 sensor cable from the connector. The screen will display the prompt information "SPO2 SENSOR OFF" and the audible alarm is activated.**
- **ES (Electrosurgery) equipment wire and SpO_2 cable must not be tangled up.**
- **Do not put the SpO_2 sensor on the limb with arterial catheter or venous syringe.**
- **Do not perform SpO_2 and NIBP measurements on the same limb simultaneously. Obstruction of blood flow during NIBP measurements may adversely affect the reading of the SpO_2 value.**
- **Prolonged and continuous monitoring may increase the risk of burns at the site of the sensor. It is especially important to check the sensor placement, and ensure proper attachment on neonates and patients of poor perfusion or skin sensitive to light. Check the sensor location every 2 to 3 hours and move to another location if the skin deteriorates. More frequent examinations may be required for different patients.**

12.2.3 Monitoring Procedure

Sensor selection for SpO_2 measurement depends on the patient type. For an adult patient, you can choose a finger SpO_2 sensor; for an infant patient, you can choose a hand or toe sensor. Refer to the following procedure.

1. Power on the monitor.
2. Attach the sensor to the proper site on the patient.
3. Plug the connector of the sensor extension cable into the SpO_2 connector on monitor.

12.2.3.1 Finger Sensor Placement

You can easily place the finger sensor as shown below.

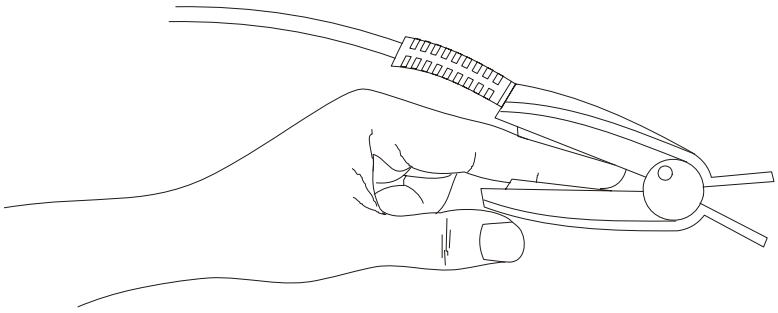


Figure 12-2 Finger Sensor Placement

NOTE

- **Place the SpO_2 sensor cable at the backside of the patient hand. Make sure the fingernail is just opposite to the light emitted from the sensor.**

12.2.3.2 Neonate Sensor Placement

Neonate SpO_2 sensor consists of a Y-shape SpO_2 sensor and its sheath. Insert the LED and PD ends of the Y-shape SpO_2 sensor respectively into the upper and lower grooves on the sheath (Figure 12-3). The Figure 12-4 shows us the neonate SpO_2 sensor after insertion.

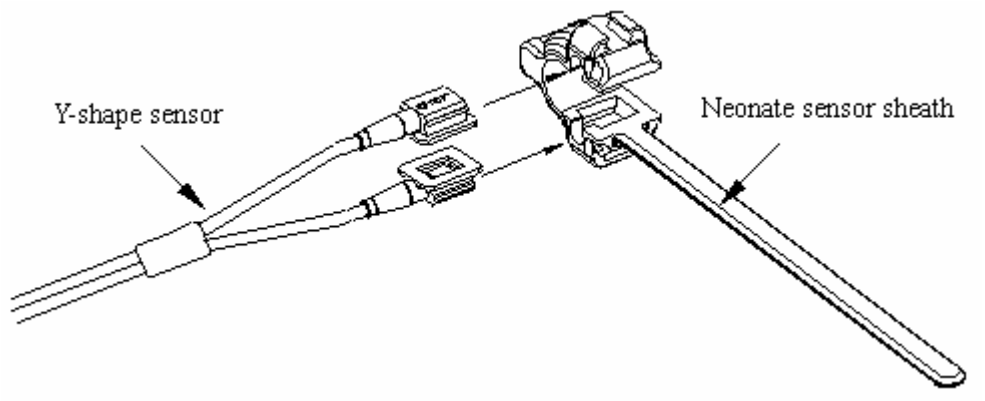


Figure 12-3 Neonate Sensor Placement (1)

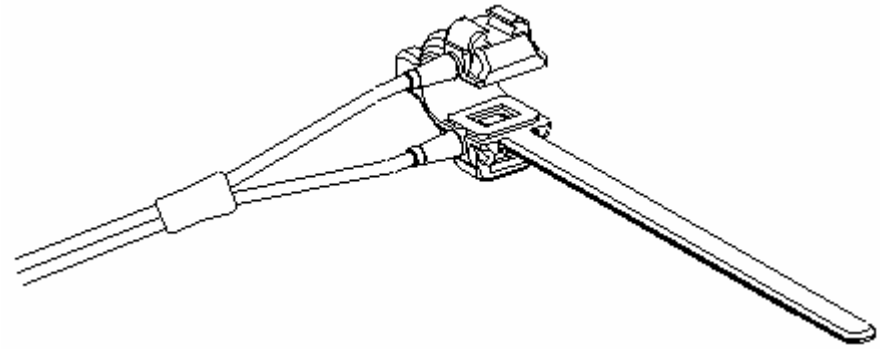


Figure 12-4 Neonate Sensor Placement (2)

Wind the SpO_2 sensor around a hand or foot of a neonate patient. Hold the sensor, pull the belt and fit one of its sides with "V" edge into the "V" groove on the corresponding side of the sheath. Appropriately elongate the belt to about 20mm, and fit the "V" edge of the other side of the belt into the "V" groove of the other side of the sheath. Then, loosen the belt. After the "V" edges of the two sides of the belt fit well into the "V" grooves on the two sides of the sheath, put the belt into the first lock bar to fasten the belt. SeeFigure 12-5. If the belt is too long, you may put it into the second lock bar. You must position the SpO_2 sensor in this way so as to make the photoelectric component face the correct position. Besides, note not to elongate the belt too much, which may lead to inaccurate measurement and block the blood circulation severely.



Figure 12-5 Neonate Sensor Placement (3)

NOTE

- **If the sensor cannot be positioned accurately to the part to be measured, it may result in inaccurate SpO_2 reading, or the SpO_2 even cannot be measured because no pulse is detected. In this case, you must position the sensor again.**
- **The excessive patient movement may result in inaccurate reading. In this situation, you must keep the patient quiet or change the measured position to reduce the adverse influence of excessive movement.**

⚠WARNING

- **In the process of extended and continuous monitoring, you should check the peripheral circulation and the skin every 2 hours. If any unfavorable change takes place, you should change the measured position in time.**
- **In the process of extended and continuous monitoring, you should periodically check the position of the sensor. In case that the position of the sensor moves during monitoring, the measurement accuracy may be affected.**

12.2.4 Measurement Limitations

If the accuracy of any measurement does not seem reasonable, first check the patient's vital signs by an alternate method. Then check the instrument for proper function. Inaccurate measurements may be caused by:

- Improper SpO_2 sensor;
- High-frequency electrical noise, including noise created by the host system, or noise from external sources, such as electrosurgical apparatus connected to the system;
- Oximeters and oximetry sensors used during magnetic resonance imaging (MRI) scanning. Induced current could potentially cause burns;
- Intravascular dye injections;
- Excessive patient motion;

- Excessive ambient light;
- Improper sensor installation or incorrect sensor placement on the patient
- Sensor temperature (optimal temperature is between 28℃ and 42℃);
- The sensor is placed on a limb that is attached to a blood pressure cuff, arterial catheter, or intravascular line;
- Concentration of dysfunctional hemoglobin, such as carboxyhemoglobin and methemoglobin;
- SpO_2 too low;
- Low circular perfusion of the applied part;
- Shock, anemia, low temperature and application of vasomotor all reduce the arterial blood flow and may affect the pulse oximetry measurement.

The absorption of oxyhemoglobin (HbO_2) and deoxyhemoglobin to the light of special wavelength may also affect SpO_2 measurement. If there exist other substances (like carbon hemoglobin, methemoglobin, methylene blue and indigo carmine) absorbing the light of the same wavelength, they may result in false or low SpO_2 reading.

12.2.5 SpO_2 Setup Menu

Selecting the SPO_2 label in the parameter window opens the following menu.

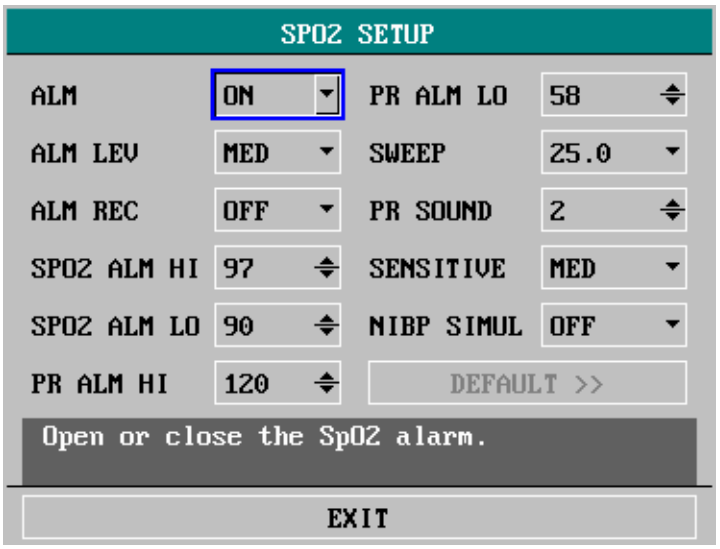


Figure 12-6 SpO_2 Setup Menu

You can perform the following settings in this menu.

- ALM — SpO_2 alarm on/off status
  ON: When a SpO_2 alarm occurs, the monitor gives alarm indications and stores the alarm;
  OFF: When a SpO_2 alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
  When OFF is selected, the icon is displayed on the right of the SPO2 label.
- ALM LEV — Alarm level
  Options: HIGH, MED and LOW.
- ALM REC — Alarm recording
  ON: When a SpO_2 alarm occurs, the monitor enables the recording;
  OFF: When a SpO_2 alarm occurs, the monitor does not enable the recording.
- SPO2 ALM HI — SpO_2 upper alarm limit
- SPO2 ALM LO — SpO_2 lower alarm limit
- PR ALM HI — PR upper alarm limit
- PR ALM LO — PR lower alarm limit

SpO_2 and PR alarm limits:

Parameter	Max. upper limit	Min. lower limit	Step
SpO_2	100	0	1
PR	254	0	1

The default SpO_2 and PR alarm limits:

Parameter	Patient type	Upper limit	Lower limit
SpO_2	Adult	100	90
	Pediatric	100	90
	Neonate	95	80
PR	Adult	120	50
	Pediatric	160	75
	Neonate	200	100

⚠WARNING

- **Setting the SpO_2 upper alarm limit to 100% will disable the upper alarm limit. High oxygen levels may predispose a premature infant to retrolental fibroplasia. Therefore, the upper alarm limit for oxygen saturation must be carefully selected in accordance with the commonly accepted clinical practices.**

- SWEEP — Waveform speed
  Options: 12.5 and 25.0 mm/s.
- PR SOUND — Pulse volume
  Range: 0 – 10. 0 indicates the volume is closed and 10 indicates the maximum volume.
- SENSITIVE — Sensitivity of SpO_2 calculation
  Options: HIGH, MED and LOW.
  When HIGH is selected, the monitor gives quick response to the change of the oxygen saturation but the measurement accuracy might be compromised.
  When LOW is selected, the monitor gives slow response to the change of the oxygen saturation but the accuracy is relatively high.
- NIBP SIMUL — ON: When measuring NIBP and SpO_2 at the same side, the SpO_2 alarm status remains unchanged until the NIBP measurement is finished;
  OFF: The function of NIBP SIMUL is disabled.
- DEFAULT — You can select this option to access the SPO2 DEFAULT CONFIG menu, in which you may select FACTORY DEFAULT CONFIG or USER DEFAULT CONFIG. After finishing your selection and exiting the menu, the system pops up a dialog box asking for your confirmation.

12.3 Masimo SpO_2 Module

NOTE

- **This section is only applicable to the monitor equipped with a Masimo SpO_2 module.**

12.3.1 Principles of Operation

The pulse oximetry measurement module (Masimo Set, which is called MS-7) is based on three principles:

- Oxyhemoglobin and deoxyhemoglobin differ in their absorption of red and infrared light (spectrophotometry).
- The volume of arterial blood in tissue and the light absorbed by the blood changes during the pulse (plethysmography).
- Arterio-venous shunting is highly variable, and the fluctuating absorbance by venous blood is a major component of noise during the pulse.

The working principle of MS-7 uses is similar to the traditional SpO_2 module. It calculates the SpO_2 value by passing red and infrared light into a capillary bed and measuring changes in light absorption during the pulsatile cycle. The red and infrared light-emitting diodes (LEDs) in oximetry sensors serve as the light sources, and the photodiode serves as the photodetector.

Traditional pulse oximeter assumes that all pulsations in the light absorbance signal are caused by oscillations in the arterial blood volume. This assumes that the blood flow in the region of the sensor passes entirely through the capillary bed rather than through any arterio-venous shunts. The traditional pulse oximeter calculates the ratio of pulsatile absorbance (AC) to the mean absorbance (DC) at each of two wavelengths, 660 nm and 940 nm:

$$\mathrm{Re}\,d(660) = AC(660)/DC(660)$$

$$Ir(940) = AC(940)/DC(940)$$

This traditional instrument then calculates the ratio of these two arterial pulse-added

absorbance signals:

$$R = \mathrm{Re}\,d(660) / Ir(940)$$

This value of R is used to find the SpO_2 in a look-up table built into the instrument's software. The values in the look-up table are based upon human blood studies against a laboratory co-oximeter on healthy adult volunteers in induced hypoxia studies.

This MS-7 assumes that arterio-venous shunting is highly variable and that fluctuating absorbance by venous blood is the major component of noise during the pulse. The MS-7 decomposes S(660) and S(940) into an arterial signal plus a noise component and calculates the ratio of the arterial signals without the noise:

$$\mathrm{Re}\,d(660) = Sr + Nr$$

$$Ir(940) = Si + Ni$$

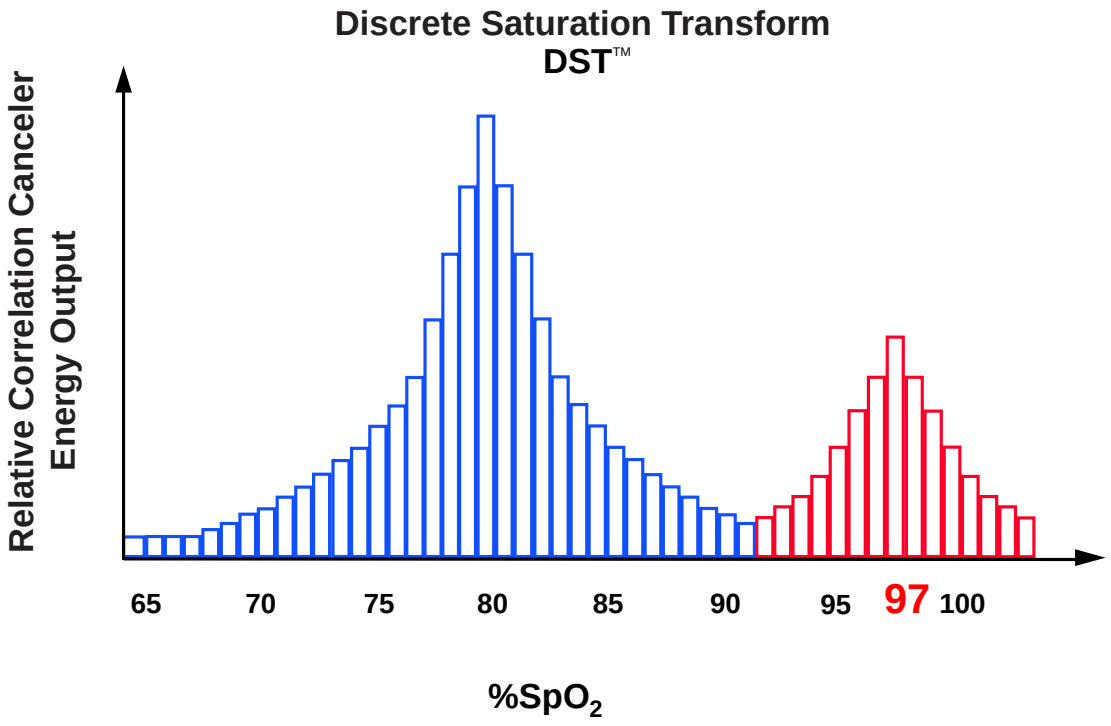
$$R = Sr / Si$$

Again, R is the ratio of two arterial pulse-added absorbance signals and its value is used to find the saturation SpO_2 in an empirically derived equation into the software. The values in the empirically derived equation are based upon human blood studies against a laboratory co-oximeter on healthy adult volunteers in induced hypoxia studies.

The above equations are combined and a noise reference (N') is determined:

$$N' = \mathrm{Re}\,d(660) - Ir(940) \times R$$

The equation for the noise reference is based on the value of R, the value being seeked to determine the SpO_2. This instrument's software sweeps through possible values of R that correspond to SpO_2 values between 1% and 100% and generates an N' value for each of these R values. The S (660) and S (940) signals are processed with each possible N' noise reference through an adaptive correlation canceler (ACC) which yields an output power for each possible value of R (i.e., each possible SpO_2 from 1% to 100%). The result is a Discrete Saturation Transform (DST™) plot of relative output power versus possible SpO2 value as shown in the following figure where R corresponds to SpO_2 = 97%:



The DST plot has two peaks: the peak corresponding to the higher saturation is selected as the SpO_2 value. This entire sequence is repeated once every two seconds on the most recent four seconds of raw data. The SpO_2 value therefore corresponds to a running average of arterial hemoglobin saturation that is updated every two seconds.

12.3.2 Precautions

⚠WARNING

- **The pulse wave from the MS-7 module must NOT be used for apnea monitoring.**
- **As a trend towards patient deoxygenation is indicated, blood samples should be analyzed by a laboratory co-oximeter to completely understand the patient's condition.**
- **If an alarm condition (other than exceptions listed herein) occurs in the Alarms Silenced status, the monitor only gives visual alarm symbols.**
- **Measure the monitor's leakage current whenever an external device is connected to the serial port. Leakage current must not exceed 100 microamperes.**

- **To ensure patient electrical isolation, connect only to other equipment with electronically isolated circuits.**
- **Do not connect to an electrical outlet controlled by a wall switch or dimmer.**
- **Carefully route patient cabling to reduce the possibility of patient entanglement or strangulation.**
- **Interfering Substances: Carboxyhemoglobin may erroneously increase readings. The level of increase is approximately equal to the amount of carboxyhemoglobin present. Dyes, or any substance containing dyes, that change usual arterial pigmentation may cause erroneous readings.**
- **Do not use this instrument and the sensors during magnetic resonance imaging (MRI). Induced current could potentially cause burns. The monitor may affect the MRI image, and the MRI unit may affect the accuracy of the oximetry measurements.**
- **The SpO_2 value might be overestimated in the presence of Hb-CO, Met-Hb or dye dilution chemicals.**
- **Verify sensor cable fault detection before beginning monitoring. Unplug the SpO_2 sensor cable from the connector. The screen displays the prompt information "SPO2 SENSOR OFF" and the audible alarm is activated.**
- **Do not use the supplied sterile SpO_2 sensors if the packaging or the sensor is damaged. Return them to the distributor or manufacturer.**
- **Do not perform SpO_2 and NIBP measurements on the same limb simultaneously. Obstruction of blood flow during NIBP measurements may adversely affect the reading of the SpO_2 value.**
- **Prolonged and continuous monitoring may increase the risk of burns at the site of the sensor. It is especially important to check the sensor placement, and ensure proper attachment on neonates and patients of poor perfusion or skin sensitive to light. Check the sensor location every 2–3 hours and move to another location if the skin deteriorates. More frequent examinations may be required for different patients.**

NOTE

- **Place the SpO_2 sensor cable at the backside of the patient hand. Make sure the patient nail is just opposite to the light emitted from the sensor.**

12.3.3 Monitoring Procedure

Follow the procedure as below:

1. Power on the monitor.
2. Attach the sensor to the proper site on the patient.
3. Plug the connector of the sensor extension cable into the SpO_2 connector on monitor.

The process of SpO_2 plethysmogram measurement is generally the same. But the SpO_2 sensor selection and placement depend on the patient type. When choosing a site for a sensor, refer to the directions for that sensor.

12.3.4 Measurement Limitations

If the accuracy of any measurement does not seem reasonable, first check the patient's vital signs by an alternate method. Then check the instrument for proper function. Inaccurate measurements may be caused by:

- Incorrect sensor application or use;
- Significant levels of dysfunctional hemoglobins (e.g., carboxyhemoglobin or methemoglobin);
- Intravascular dyes such as indocyanine green or methylene blue;
- Exposure to excessive illumination, such as surgical lamps (especially ones with a xenon light source), bilirubin lamps, fluorescent lights, infrared heating lamps, or direct sunlight (exposure to excessive illumination can be corrected by covering the sensor with a dark material);
- Excessive patient motion;
- Venous pulsations;
- Placement of a sensor on the same extremity with a blood pressure cuff, arterial catheter, or intravascular line;
- The monitor can be used during defibrillation. However, the readings may take a short period of time to return to normal.

Loss of pulse signal can occur in the following situations:

- The sensor is too tight;
- There is excessive illumination from light sources such as a surgical lamp, a bilirubin lamp, or sunlight;

- A blood pressure cuff is inflated on the same extremity as the one with a SpO_2 sensor attached;
- The patient has hypotension, severe vasoconstriction, severe anemia, or hypothermia;
- There is arterial occlusion proximal to the sensor;
- The patient is in cardiac arrest or is in shock.

12.3.5 SpO_2 Setup Menu

Selecting the SPO_2 label in the parameter window opens the following menu.

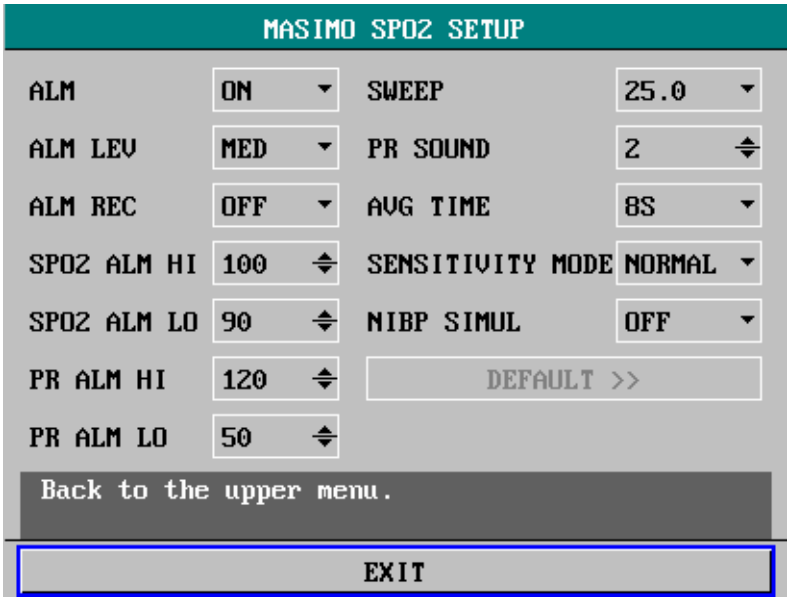


Figure 12-7 MASIMO SpO_2 Setup Menu

You can perform the following settings in this menu.

- ALM — SpO_2 alarm on/off status
  ON: When a SpO_2 alarm occurs, the monitor gives alarm indications and stores the alarm;
  OFF: When a SpO_2 alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
  When OFF is selected, the icon is displayed on the right of the SPO_2 label.
- ALM LEV — Alarm level
  Options: HIGH, MED and LOW.

- ALM REC Alarm recording

  ON: When a SpO_2 alarm occurs, the monitor enables the recording;

  OFF: When a SpO_2 alarm occurs, the monitor does not enable the recording.
- SPO2 ALM HI SpO_2 upper alarm limit
- SPO2 ALM LO SpO_2 lower alarm limit
- PR ALM HI PR upper alarm limit
- PR ALM LO PR lower alarm limit

SpO_2 and PR alarm limits:

Parameter	Max. upper limit	Min. lower limit	Step
SpO2	100	0	1
PR	240	0	1

The default SpO_2 and PR alarm limits:

Parameter	Patient type	Upper limit	Lower limit
SpO2	Adult	100	90
	Pediatric	100	90
	Neonate	95	80
PR	Adult	120	50
	Pediatric	160	75
	Neonate	200	100

⚠WARNING

- **Setting the SpO_2 upper alarm limit to 100% will disable the upper alarm limit. High oxygen levels may predispose a premature infant to retrolental fibroplasia. Therefore, the upper alarm limit for oxygen saturation must be carefully selected in accordance with the commonly accepted clinical practices.**

- SWEEP Waveform speed

  Options: 12.5 and 25.0 mm/s.

- PR SOUND — Pulse volume
  Range: 0 – 10. 0 indicates the volume is closed and 10 indicates the maximum volume.
- AVG TIME — Average time
  Determines the average SpO_2 calculation time.
  Options: 2-4S, 4-6S, 8S, 10S, 12S, 14S and 16S.
- SENSITIVITY MODE — Options: NORMAL and HIGH.
- NIBP SIMUL — ON: When measuring NIBP and SpO_2 at the same side, the SpO_2 alarm status remains unchanged until the NIBP measurement is finished;
  OFF: The function of NIBP SIMUL is disabled.
- DEFAULT — You can select this option to access the SPO2 DEFAULT CONFIG menu, in which you may select FACTORY DEFAULT CONFIG or USER DEFAULT CONFIG. After finishing your selection and exiting the menu, the system pops up a dialog box asking for your confirmation.

12.3.6 Sensors and Accessories

If your monitor is equipped with a Masimo SpO_2 module, use only Masimo oximetry sensors for SpO_2 measurements. Other sensors may cause improper pulse oximeter performance. Before use, carefully read the directions for the LNOP sensor. Tissue damage can be caused by incorrect application or use of a sensor. An example is wrapping the sensor too tightly. Inspect the sensor site as specified in the directions to ensure skin integrity, correct positioning, and adhesion of the sensor.

⚠CAUTION

- **Do not use damaged sensors. Do not use a sensor with exposed optical components. Do not immerse the sensor in water, solvents, or cleaning solutions (the sensors and connectors are not waterproof). Do not sterilize by irradiation, steam, or ethylene oxide.**
- **Do not use damaged patient cables. Do not immerse the patient cables in water, solvents, or cleaning solutions (the sensors and connectors are not waterproof). Do not sterilize by irradiation, steam, or ethylene oxide.**

12.3.6.1 Selecting a Masimo sensor

When selecting a sensor, consider, the patient's weight, the adequacy of perfusion, the available sensor sites, and the duration of monitoring. For more information contact Masimo. Use only Masimo sensors and sensor cables. Select an appropriate sensor, apply as directed, and observe all warnings and cautions presented in the directions for use accompanying the sensor.

High ambient light sources such as surgical lights (especially those with a xenon light source), bilirubin lamps, fluorescent lights, infrared heating lamps, and direct sunlight can interfere with the performance of a SpO_2 sensor. To prevent interference from ambient light, ensure that the sensor is properly applied, and cover the sensor site with dark, opaque material, if required. Failure to take this precaution in high ambient light conditions may result in inaccurate measurements.

12.3.6.2 Selecting Masimo Sensor Cables

Only use Masimo oximetry patient cables for SpO_2 measurements. Other patient cables may cause improper pulse oximeter performance.

Reusable patient cables of various lengths are available. All cables that marked by the Masimo SET logo are designed to work with any Masimo LNOP sensor, and with any pulse oximeter or multi-parameter instrument marked by the Masimo SET logo.

NOTE

- **Carefully route patient cables to reduce the possibility of patient entanglement or strangulation.**
- **If the sensor fails to track the pulse consistently, the sensors may be incorrectly positioned. Reposition the sensor or choose a different monitoring site.**

12.3.6.3 Cleaning and Reusing a Masimo LNOP Sensor

Reusable sensors can be cleaned per the following procedure:

1. Remove the sensor from the patient.
2. Disconnect the sensor from the monitor.
3. Wipe the entire sensor with a 70% isopropyl alcohol pad, and clean with a dry cloth.
4. Allow the sensor to air-dry before returning it to operation.

This method can be used to clean emitting and receiving parts too. The cables should be cleaned with a 3% Hydrogen peroxide, a 70% isopropyl alcohol or other solutions. Keep the cleaning solution away from the sensor connections.

Reattaching a Disposable Adhesive Sensor:

- LNOP single use sensors may be reapplied to the same patient if the emitter and detector windows are clear and the adhesive still adheres to the skin;
- The adhesive can be partially rejuvenated by wiping with a 70% isopropyl alcohol wipe and allowing the sensor to thoroughly air-dry prior to replacement on the patient.

⚠WARNING

- **To avoid cross contamination only use Masimo LNOP disposable sensors on the same patient.**
- **Before cleaning the monitor or the sensor, make sure the equipment is switched off and disconnected from AC power.**

⚠CAUTION

- **Do not reuse Masimo LNOP disposable sensors.**
- **Do not soak or immerse patient cables in any liquid solution. Do not sterilize patient cables by irradiation steam or ethylene oxide. See the cleaning instructions for use for reusable Masimo patient cables.**

12.3.7 Masimo Information

The MASIMO SET® Product



Masimo Patents

This device is covered under one or more the following U.S. Patents: 5,482,036; 5,490,505; 5,632,272; 5,685,299; 5,758,644; 5,769,785; 6,002,952; 6,036,642; 6,067,462; 6,206,830; 6,157,850 and international equivalents. U.S.A and international patents pending.

No Implied License

Possession or purchase of this device does not convey any express or implied license to use the device with replacement parts which would, alone, or in combination with this device, fall within the scope of one or more of the patents relating to this device.

12.4 Nellcor SpO_2 Module

NOTE

- **This section is only applicable to the monitor equipped with a Nellcor SpO_2 module.**

12.4.1 Principles of Operation

Bone, tissue, pigmentation, and venous vessels normally absorb a constant amount of light over time. The arteriolar bed normally pulsates and absorbs variable amounts of light during the pulsations. The Nellcor SpO_2 module uses pulse oximetry to measure functional oxygen saturation in the blood. Pulse oximetry works by applying a sensor to a pulsating arteriolar vascular bed, such as a finger or toe. The sensor contains a dual light source and a photodetector. The ratio of light absorbed is translated into a measurement of functional oxygen saturation (SpO_2).

■ Oximetry Overview

Pulse oximetry is based on two principles:

1. Oxyhemoglobin and deoxyhemoglobin differ in their absorption of red and infrared light (i.e., spectrophotometry).
2. The volume of arterial blood in tissue (and hence, light absorption by that blood) changes during the pulse (i.e., plethysmography).

A monitor determines SpO_2 by passing red and infrared light into an arteriolar bed and measuring changes in light absorption during the pulsatile cycle. Red and infrared low-voltage light-emitting diodes (LEDs) in the oximetry sensor serve as light sources; a photodiode serves as the photo detector.

Because oxyhemoglobin and deoxyhemoglobin differ in light absorption, the amount of red and infrared light absorbed by blood is related to hemoglobin oxygen saturation. To identify the oxygen saturation of arterial hemoglobin, the monitor uses the pulsatile nature of arterial flow. During systole, a new pulse of arterial blood enters the vascular bed, and blood volume and light absorption increase. During diastole, blood volume and light absorption reach their lowest point. The monitor bases its SpO_2 measurements on the difference between maximum and minimum

absorption (i.e., measurements at systole and diastole). By doing so, it focuses on light absorption by pulsatile arterial blood, eliminating the effects of nonpulsatile absorbers such as tissue, bone, and venous blood.

■ Automatic Calibration

Because light absorption by hemoglobin is wavelength dependent and because the mean wavelength of LEDs varies, a monitor must know the mean wavelength of the sensor's red LED to accurately measure SpO_2. During manufacturing, the mean wavelength of the red LED is encoded in a resistor in the sensor. During monitoring, the monitor reads this resistor and selects coefficients that are appropriate for the wavelength of that sensor's red LED; these coefficients are then used to determine SpO_2.

This resistor is read when the monitor is turned on, periodically thereafter, and each time a new sensor is connected. Additionally, to compensate for differences in tissue thickness, the intensity of the sensor's LEDs is adjusted automatically.

■ Functional versus Fractional Saturation

This monitor measures functional saturation — oxygenated hemoglobin expressed as a percentage of the hemoglobin that can transport oxygen. It does not detect significant amounts of dysfunctional hemoglobin, such as carboxyhemoglobin or methemoglobin. In contrast, some instruments report fractional saturation — oxygenated hemoglobin expressed as a percentage of all measured hemoglobin, including measured dysfunctional hemoglobins. To compare functional saturation measurements to those from an instrument that measures fractional saturation, fractional measurements must be converted as follows:

$$\text{Functional saturation} = \frac{\text{Fractional saturation}}{100 - (\%\text{carboxyhemoglobin} + \%\text{methemoglobin})} \times 100$$

■ Measured versus Calculated Saturation

When saturation is calculated from a blood gas partial pressure of oxygen (PO_2), the calculated value may differ from the SpO_2 measurement of a monitor. This usually occurs because the calculated saturation was not appropriately corrected for the effects of variables that shift the relationship between PO_2 and saturation (Figure 12-8): pH, temperature, the partial pressure of carbon dioxide (PCO_2), 2,3-DPG, and fetal hemoglobin.

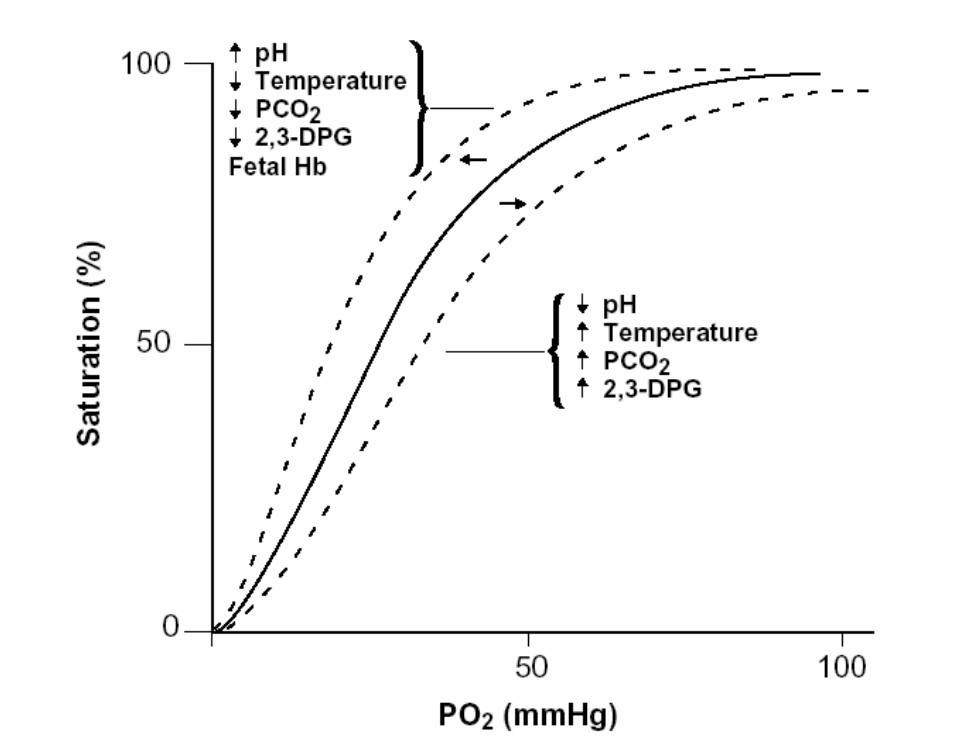


Figure 12-8 Oxyhemoglobin Dissociation Curve

12.4.2 Precautions

⚠WARNING

- **Pulse oximeter can overestimate the SpO_2 value in the presence of Hb-CO, Met-Hb or dye dilution chemicals.**
- **ES (Electrosurgery) equipment wire and SpO_2 cable must not be tangled up. Carefully route patient cabling to reduce the possibility of patient entanglement or strangulation.**
- **Do not use this instrument and the sensors during magnetic resonance imaging (MRI). Induced current could potentially cause burns. The monitor may affect the MRI image, and the MRI unit may affect the accuracy of the oximetry measurements.**
- **Do not put the SpO_2 sensor on the limb with arterial catheter or venous syringe.**
- **Do not use the supplied sterile SpO_2 sensors if the packaging or the sensor is damaged. Return them to the distributor or manufacturer.**

⚠WARNING

- **Do not perform SpO_2 monitoring and NIBP measurements on the same arm simultaneously. Obstruction of blood flow during NIBP measurements may adversely affect the reading of the SpO_2 value.**
- **Before performing the testing, check the sensor cable. After unplugging the SpO_2 sensor cable from the socket, the system shall display the prompt information "SPO2 SENSOR OFF" and give the audible alarm.**
- **Prolonged and continuous monitoring may increase the risk of burns at the site of the sensor. It is especially important to check the sensor placement, and ensure proper attachment on neonates and patients of poor perfusion or skin sensitive to light. Check the sensor location every 2–3 hours and move to another location if the skin deteriorates. More frequent examinations may be required for different patients.**

NOTE

- **Place the SpO_2 sensor cable at the backside of the patient hand. Make sure the fingernail is just opposite to the light emitted from the sensor.**

12.4.3 Monitoring Procedure

Follow the procedure as below:

1. Power on the monitor.
2. Attach the sensor to the proper site on the patient.
3. Plug the connector of the sensor extension cable into the SpO_2 connector on monitor.

The process of SpO_2 plethysmogram measurement is generally the same. But the SpO_2 sensor selection and placement depend on the patient type. When choosing a site for a sensor, refer to the directions for that sensor.

12.4.4 Measurement Limitations

If the accuracy of any measurement does not seem reasonable, first check the patient's vital signs by an alternate method. Then check the instrument for proper function.

Inaccurate measurements may be caused by:

- Incorrect sensor application or use;
- Placement of a sensor on the same extremity with a blood pressure cuff, arterial catheter, or intravascular line;
- Exposure to excessive illumination, such as surgical lamps (especially ones with a xenon light source), bilirubin lamps, fluorescent lights, infrared heating lamps, or direct sunlight (exposure to excessive illumination can be corrected by covering the sensor with a dark material);
- Excessive patient motion;
- Venous pulsations;
- Intravascular dyes such as indocyanine green or methylene blue;
- Defibrillation;

Other physiological conditions or medical procedures that may interfere with the monitor's measurements include significant levels of dysfunctional hemoglobin, low perfusion, and dark pigment.

Loss of pulse signal can occur in the following situations:

- The sensor is too tight;
- A blood pressure cuff is inflated on the same extremity as the one with a SpO2 sensor attached;
- There is arterial occlusion proximal to the sensor.

Select an appropriate sensor, apply it as directed, and observe all warnings and cautions presented in the directions for use accompanying the sensor. Clean and remove any substances such as nail polish from the application site. Periodically check to ensure that the sensor remains properly positioned on the patient.

If patient movement presents a problem, try one or more of the following remedies to correct the problem.

- Verify that the sensor is properly and securely applied.
- Move the sensor to a less active site.
- Use an adhesive sensor that tolerates some patient motion.
- Use a new sensor with fresh adhesive backing.

If poor perfusion affects performance, consider using the Oxisensor R-15 sensor; it obtains measurements from the nasal septal anterior ethmoid artery, an artery supplied by the internal carotid. This sensor may obtain measurements when peripheral perfusion is relatively poor. For low peripheral perfusion, consider using the Nellcor RS-10 sensor, which is applied to the forehead or temple. These are sites that may be spared during peripheral vasoconstriction.

12.4.5 SpO_2 Setup Menu

Selecting the SPO_2 label in the parameter window opens the following menu.

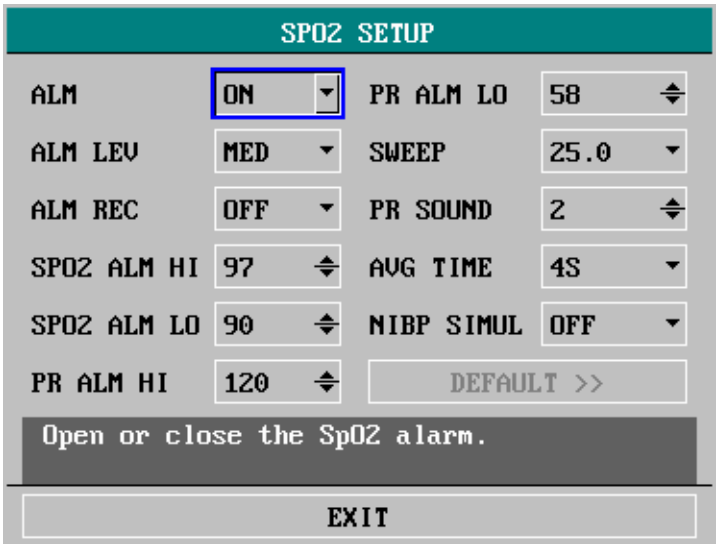


Figure 12-9 SpO_2 Setup Menu

You can perform the following settings in this menu.

- ALM — SpO_2 alarm on/off status
  ON: When a SpO_2 alarm occurs, the monitor gives alarm indications and stores the alarm;
  OFF: When a SpO_2 alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
  When OFF is selected, the icon is displayed on the right of the SPO2 label.
- ALM LEV — Alarm level
  Options: HIGH, MED and LOW.
- ALM REC — Alarm recording
  ON: When a SpO_2 alarm occurs, the monitor enables the recording;

OFF: When a SpO_2 alarm occurs, the monitor does not enable the recording.

- SPO2 ALM HI SpO_2 upper alarm limit
- SPO2 ALM LOW SpO_2 lower alarm limit
- PR ALM HI PR upper alarm limit
- PR ALM LO PR lower alarm limit

SpO_2 and PR alarm limits:

Parameter	Max. upper limit	Min. lower limit	Step
SpO_2	100	0	1
PR	300	20	1

The default SpO_2 and PR alarm limits:

Parameter	Patient type	Upper limit	Lower limit
SpO_2	Adult	100	90
	Pediatric	100	90
	Neonate	95	80
PR	Adult	120	50
	Pediatric	160	75
	Neonate	200	100

⚠WARNING

- **Setting the SpO_2 upper alarm limit to 100% will disable the upper alarm limit. High oxygen levels may predispose a premature infant to retrolental fibroplasia. Therefore, the upper alarm limit for oxygen saturation must be carefully selected in accordance with the commonly accepted clinical practices.**

- SWEEP Waveform speed
  Options: 12.5 and 25.0 mm/s.
- PR SOUND Pulse volume
  Range: 0 – 10. 0 indicates the volume is closed and 10 indicates the maximum volume.

- AVG TIME — Average time
  Determines the average SpO_2 calculation time.
  Options: 4S, 8S and 16S.
- NIBP SIMUL — ON: When measuring NIBP and SpO_2 at the same side, the SpO_2 alarm status remains unchanged until the NIBP measurement is finished;
  OFF: The function of NIBP SIMUL is disabled.
- DEFAULT — You can select this option to access the SPO2 DEFAULT CONFIG menu, in which you may select FACTORY DEFAULT CONFIG or USER DEFAULT CONFIG. After finishing your selection and exiting the menu, the system pops up a dialog box asking for your confirmation.

12.4.6 Accessories

If your monitor is equipped with a Nellcor SpO_2 module, use only Nellcor oximetry sensors for SpO_2 measurements. Other sensors may cause improper pulse oximeter performance. Before use, carefully read the directions for the sensor. When selecting a sensor, consider, the patient's weight and motion, the adequacy of perfusion, the available sensor sites, and the required disinfection.

Biocompatibility testing has been conducted on Nellcor sensors in compliance with ISO 10993-1, Biological Evaluation of Medical Devices, Part 1: Evaluation and Testing. The sensors have passed the recommended biocompatibility testing and are therefore in compliance with ISO 10993-1.

Before attempting to clean a SpO_2 sensor, read the directions for use enclosed with the sensor. Each sensor model has cleaning instructions specific to that sensor.

⚠WARNING

- **Incorrect use of an oximetry sensor may cause damage to the patient's muscle. Verify the sensor site carefully according to the directions for use.**

12.4.7 Nellcor Information

Nellcor Patents

This device is covered under one or more the following U.S. Patents: 4,802,486; 4,869,254; 4,928,692; 4,934,372; 5,078,136; 5,351,685; 5,485,847; 5,533,507; 5,577,500; 5,803,910; 5,853,364; 5,865,736; 6,083,172; 6,463,310; 6,591,123; 6,708,049; Re.35,122 and international equivalents. U.S.A and international patents pending.

No Implied License

Possession or purchase of this device does not convey any express or implied license to use the device with replacement parts which would, alone, or in combination with this device, fall within the scope of one or more of the patents relating to this device.

FOR YOUR NOTES

13 NIBP Monitoring

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13.1 Overview

The Non-invasive Blood Pressure (NIBP) module measures blood pressure using the oscillometric method. This monitor can be applied to adult, pediatric, and neonatal patients. Three modes of measurement are available: manual, automatic and continuous.

- Manual: Pressing the NIBP key on the control panel starts a NIBP measurement.
- Auto: The NIBP measurement is conducted automatically at a preset interval.
- Continuous: The NIBP measurement is performed as many times as possible in five minutes.

The NIBP measurement does not produce any waveform. Instead, it displays the measurement result in the NIBP parameter window as shown below.

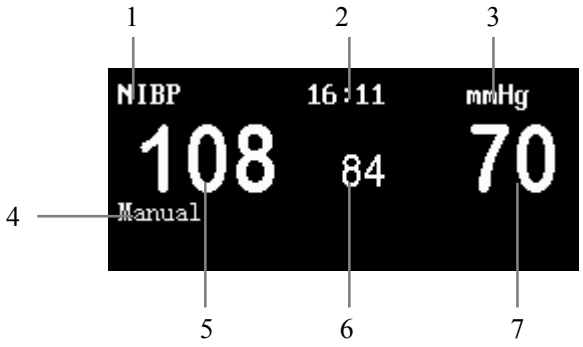


Figure 13-1 NIBP Parameter Window

1. NIBP label: Selecting this label to access the NIBP SETUP menu.
2. Time of last measurement.
3. NIBP unit: mmHg or kPa.
4. Prompt information area: Shows the NIBP measurement mode and other information.
5. Systolic pressure value (NS)
6. Mean pressure value (NM)
7. Diastolic pressure value (ND)

If a set of measured results appears in grey, it indicates this measurement is performed at least 1 hour ago.

13.2 Monitoring Procedure

⚠WARNING

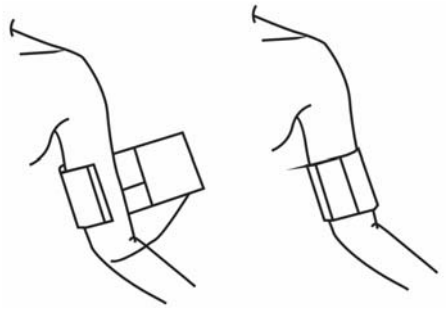
- **You must not perform NIBP measurements on patients with sickle-cell disease or under any condition in which the skin is damaged or expected to be damaged.**
- **For a thrombasthemia patient, it is important to determine whether measurement of the blood pressure shall be done automatically.**
- **Ensure that the setting is correctly made when performing measurements on children. Incorrect patient type setting may cause a danger to the patient because adult blood pressure level is higher than children.**

To perform NIBP measurement on a patient, follow the procedure as below

1. Power on the monitor.
2. Check the patient information area on the screen. If the patient type is incorrect, select a correct patient type in PATIENT SETUP menu.
3. Plug the air hose in the NIBP cuff connector of the monitor.
4. Apply a cuff of proper size to the upper arm or the leg of the patient.
5. Connect the cuff with the air hose.
6. Press the NIBP key on the control panel to start the NIBP measurement.

13.2.1 Cuff Selection and Placement

1. Identify the patient limb circumference.
2. Select appropriate cuff; limb circumference is identified on each cuff.
3. Verify the cuff is completely deflated; place cuff around extremity being used and make sure the marking ϕ matches artery location.
4. Verify the cuff is not wrapped too tightly around the limb. Excessive tightness may cause discoloration or ischemia of the extremities.



5. Make sure that the cuff edge falls within the range of the <-> mark. If it does not, use a larger or smaller cuff that will fit better.
6. The limb chosen for taking the measurement should be placed at the same level as the patient's heart. If this is not possible, use the following method to correct the measurement result:

- If the cuff is placed higher than the heart level, add 0.75 mmHg (0.10 kPa) for each centimeter of difference.
- If it is placed lower than the heart level, deduct 0.75 mmHg (0.10 kPa) for each centimeter of difference.

⚠WARNING

- **The width of the cuff should be either 40% of the limb circumference (50% for neonates) or 2/3 of the upper arm length. The inflatable part of the cuff should be long enough to circle 50-80% of the limb. The wrong size cuff can cause erroneous readings. If the cuff size is in question, use a larger cuff.**
- **Do not apply the cuff to a limb that has an intravenous infusion or catheter in place. This could cause tissue damage around the catheter when infusion is slowed or blocked during cuff inflation.**
- **Make sure the air tubing connecting the blood pressure monitor is not blocked, twisted, or tangled.**

13.2.2 Operation Guides

1. To start a manual NIBP measurement

- Access the NIBP SETUP menu and select MANUAL from the INTERVAL option; then, press the NIBP key on the control panel to start a manual NIBP measurement; or
- During the interval between two auto NIBP measurements, press the NIBP key on the control panel to start a manual NIBP measurement.

2. To start auto NIBP measurement

Access the NIBP SETUP menu and select a time (e.g. 5MIN) from the INTERVAL options; press the NIBP key on the control panel to start the auto NIBP measurment. When this measurment finishes, the system will perform the NIBP measurment automatically as per the preset interval.

⚠WARNING

- **Auto non-invasive blood pressure measurements performed in long intervals may incur ischemia and neuropathy in the limb wearing the cuff. When monitoring a patient, examine the extremities of the limb frequently for normal color, warmth and sensitivity. If any abnormality is observed, change the position of the cuff on the patient or stop the blood pressure measurements immediately.**

3. To start a continuous NIBP measurement

Selecting CONTINUAL in NIBP SETUP menu starts a continuous NIBP measurement. The monitor continues measuring NIBP for five minutes.

4. To stop a NIBP measurement

During an auto, manual or continuous measurement, pressing the NIBP key on the control panel stops the ongoing measurement.

NOTE

- **If you are in doubt about the accuracy of any reading(s), check the patient's vital signs by an alternative method before checking the function of the monitor.**

13.3 Measurement Limitations

Non-invasive blood pressure measurement uses the oscillometric method of measurement. The monitor detects the regular arterial pressure pulse. In some circumstances when the patient's condition makes it difficult to detect this pulse, the measurement becomes unreliable and the measurement time increases. You should be aware that the following conditions could interfere with the measurement, make the measurement unreliable, prolong the measurement, or even make a measurement impossible.

- Patient Movement

E.g.The patient is moving, shivering, or having convulsions.

- Cardiac Arrhythmia’s

E.g.The patient's cardiac arrhythmia has caused an irregular heartbeat.

- Heart-lung Machine

E.g. Measurements will be impossible if the patient is connected to a heart-lung machine.

- Pressure Changes

E.g.The patient's blood pressure is changing rapidly over the period of time during which the arterial pressure pulses are being analyzed to obtain the measurement.

- Severe Shock

E.g.If the patient is in severe shock or hypothermia, reduced blood flow to the peripheries will cause reduced pulsation of the arteries.

- Heart Rate Extremes

The monitor is unable to perform pressure measurements at a heart rate of less than 40 bpm and greater than 240 bpm.

13.4 NIBP Setup Menu

Selecting the NIBP label in the parameter area opens the following menu.



Figure 13-2 NIBP Setup Menu

You can perform the following settings in this menu.

- ALM — NIBP alarm on/off status
  ON: When a NIBP alarm occurs, the monitor gives alarm indications and stores the alarm;
  OFF: When a NIBP alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
  When OFF is selected, the icon is displayed on the right of the NIBP label.
- ALM LEV — Alarm level
  Options: HIGH, MED and LOW.
- ALM REC — Alarm recording
  ON: When an NIBP alarm occurs, the monitor enables the recording;
  OFF: When a NIBP alarm occurs, the monitor does not enable the recording.
- SYS ALM HI — Determines the upper limit of the systolic pressure.

- SYS ALM LO Determines the lower limit of the systolic pressure.
- MEAN ALM HI Determines the upper limit of the mean pressure.
- MEAN ALM LO Determines the lower limit of the mean pressure.
- DIA ALM HI Determines the upper limit of the diastolic pressure.
- DIA ALM LO Determines the lower limit of the diastolic pressure.

If a measured pressure crosses a preset upper or lower alarm limit, an alarm will be triggered. The NIBP alarm limits are as follows:

Patient type	Adult	Pediatric	Neonate
Systolic pressure	40–270 mmHg	40–200 mmHg	40–135 mmHg
Mean pressure	20–235 mmHg	20–165 mmHg	20–110 mmHg
Diastolic pressure	10–215 mmHg	10–150 mmHg	10–100 mmHg

- DISPLAY WAY 1 GROUP: The NIBP parameter area only displays a group of NIBP values obtained in the latest measurement.
  GROUPS: Multiple groups of measurement values are displayed at the lower left corner of the screen as shown below.

NS	NM	ND	PR	DATE	TIME
108	84	70	68	2006-6-12	16:06:00
108	80	70	67	2006-6-12	16:11:00
108	80	70	72	2006-6-12	16:16:00

- UNIT Options: mmHg, kPa;
- INTERVAL Select MANUAL to set the monitor to manual NIBP measurement mode, or select from the time options to determine the interval between automatic measurements. Optional intervals: 1, 2, 3, 4, 5, 10, 15, 30, 60, 90, 120, 180, 240, and 480MIN.
- RESET Select this option to restore the initial settings of the pressure pump. If the monitor fails to give a visual indication when the pressure pump is working improperly, selecting this option activates a self-test procedure, and restores the monitor to normal performance.
- CONTINUAL Select this option to start a continuous measurement for five minutes.

- DEFAULT >> You can select this option to access the NIBP DEFAULT CONFIG menu, in which you may select FACTORY DEFAULT CONFIG or USER DEFAULT CONFIG. After finishing your selection and exiting the menu, the system pops up a dialog box asking for your confirmation.

13.4.1 Calibration

If you select the CALIBRATE option, the monitor starts the NIBP calibration and the CALIBRATE option changes to STOP CAL. Selecting the option again stops the calibration.

Calibrate the cuff pressure reading with a calibrated reference manometer (or mercury manometer) with accuracy higher than 1mmHg. To perform the calibration, follow the procedure shown below:

1. Remove the blood pressure cuff from the monitor and replace it with a rigid metal container or vessel with a capacity of 500 ml ± 5%.
2. Connect a calibrated reference manometer (with an error less than 1mmHg) and a ball pump using “T” connectors as shown below.
3. Select the CALIBRATE option.
4. Inflate the metal container using the ball pump until the reference manometer reads 0, then 50, and finally 200 mmHg.
5. The difference between the indicated pressure of the reference manometer and the indicated pressure of the monitor will not exceed 3 mmHg. Contact our Customer Service if these values are not met.

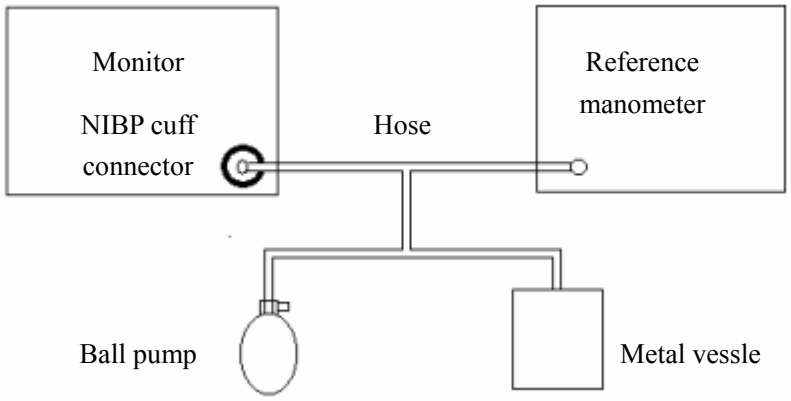


Figure 13-3 NIBP Calibration

NOTE

- **The calibration of the NIBP measurement should be performed every two years or performed according to the Hospital Procedure.**

13.4.2 Testing for Air Leakage

The PNEUMATIC option is used to test air leakage. When the NIBP cuff is connected, select this option to start the NIBP inflation and test whether the air leakage occurs in the airway. If the test is passed, no prompt information will be displayed; if the test is not passed, corresponding prompt information will be displayed in the NIBP parameter window.

To test air leakage, use the following procedure:

1. Connect the NIBP cuff with the NIBP cuff connector of the monitor.
2. Wrap the cuff around a cylinder of a proper size, as shown below.

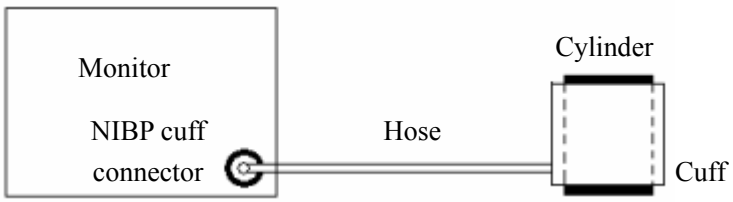


Figure 13-4 NIBP Leakage Test

3. Select the PNEUMATIC option, and the information “Pneum testing…” is displayed at the lower left corner of the NIBP parameter window.
4. After approximately 20 seconds, the monitor will automatically open the deflate valve, ending the test.
5. If no information appears on the bottom of the NIBP parameter area, it indicates the airway is in good condition and an air leak does not exist. However if the information “PNEUMATIC LEAK” appears, it indicates the airway may have an air leak. In this case, check for loose connections. After confirming all connections are secure, perform the test again.

If there is still a failure, contact our Customer Service.

NOTE

- **Set PAT TYPE to ADU in the PATIENT SETUP menu before leakage test.**
- **The pneumatic test, other than being specified in the EN 1060-1 standard, is to be used to simply determine whether there are air leaks in the NIBP airway.**

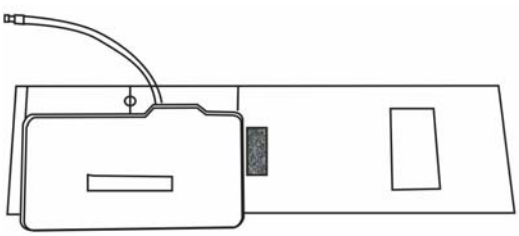
13.5 Maintenance and Cleaning

⚠WARNING

- **Do not press the rubber tube on the cuff with excessive strength.**
- **When a reusable cuff is not connected to the monitor or is being cleaned, always cover the rubber tube with a lid. Avoid splashing liquid into the rubber tube or the monitor inadvertently.**

Reusable Blood Pressure Cuffs

The cuff is not suitable for dry-cleaned. Instead, it should be machine or hand washed. Hand washing, may prolong the service life of the cuff. Before washing, remove the latex rubber bladder. Allow the cuff to dry thoroughly after washing, and then reinsert the rubber bladder. The cuff can be disinfected by means of conventional autoclaving, gas, or radiation disinfection in hot air ovens, or sterilized by immersion in decontamination solutions. Remember to remove the rubber bladder if you use this method



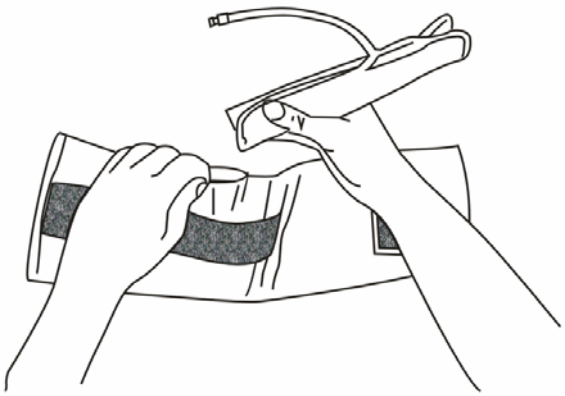


Figure 13-5 Replacing the Rubber Bladder

To replace the rubber bladder in the cuff:

1. Place the bladder on top of the cuff so the rubber tubes line up with the large opening on the long side of the cuff.
2. Roll the bladder lengthwise and insert it into the opening on the long side of the cuff.
3. Hold the tubes and the cuff and shake the complete cuff until the bladder is in position.
4. Thread the rubber tubes from inside the cuff, and out through the small hole under the internal flap.

⚠CAUTION

- **Some disinfectants may cause skin irritation. Please rinse cuff thoroughly with water to remove any residual disinfectants. Using dark colored disinfectants may stain the cuffs. Test a single cuff to ensure that no damage will occur.**

Disposable Blood Pressure Cuffs

Disposable cuffs are intended for single patient use only. Do not sterilize or use autoclave sterilization for disposable cuffs.

NOTE

- **Disposable blood pressure cuffs must be recycled or disposed of properly.**

14 TEMP Monitoring

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14.4 Maintenance and Cleaning 14-6

14.1 Overview

The monitor is able to use two temperature probes simultaneously, to obtain two temperature values and the difference between them. The measurement values are displayed in the TEMP parameter window as shown below.

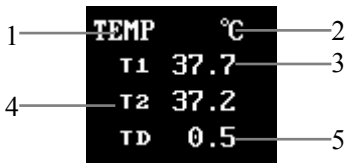


Figure 14-1 TEMP Parameter Window

1. TEMP label: Selecting this label opens the TEMP SETUP menu.
2. Temperature unit: ℃ or ℉.
3. T1: Temperature channel 1. Displays the temperature measured at temperature channel 1.
4. T2: Temperature channel 2. Displays the temperature measured at temperature channel 2.
5. TD: Temperature difference, namely the difference between temperature 1 and temperature 2.

14.2 Measurement Procedure

To measure the temperature of a patient,

1. If a disposable temperature probe is used, plug the temperature probe cable in the temperature probe connector on the side panel of the monitor, and then connect the temperature probe with the cable; if a reusable temperature probe is used, connect the temperature probe with the temperature probe connector directly.
2. Attach the temperature probe to the patient properly.
3. Power on the monitor.

NOTE

- **Disposable temperature probes are for single patient use only.**
- **The self-test of the temperature measurement is performed once per hour during monitoring. This self-test lasts about 2 seconds and does not affect the normal measurement of temperature.**

⚠WARNING

- **Verify probe cable fault detection before beginning monitoring. Unplug the temperature probe cable of channel 1 or channel 2 from the connector on the monitor. The monitor will display the prompt information "T1 SENSOR OFF" or "T2 SENSOR OFF" and an audible alarm is activated. The other channel is the same.**
- **Be careful to avoid damaging the temperature probe and cable. When the temperature probe and cable are not in use, shape them into a loose round. If the cable is tangled too tightly or over-bent, mechanical damage may occur.**
- **The calibration of the temperature measurement function is required every two years (or as dictated by your Hospital Procedures Policy). If you need to calibrate the temperature measurement function, contact our Customer Service.**

14.3 TEMP Setup Menu

Selecting the TEMP label in the parameter window opens the following menu.

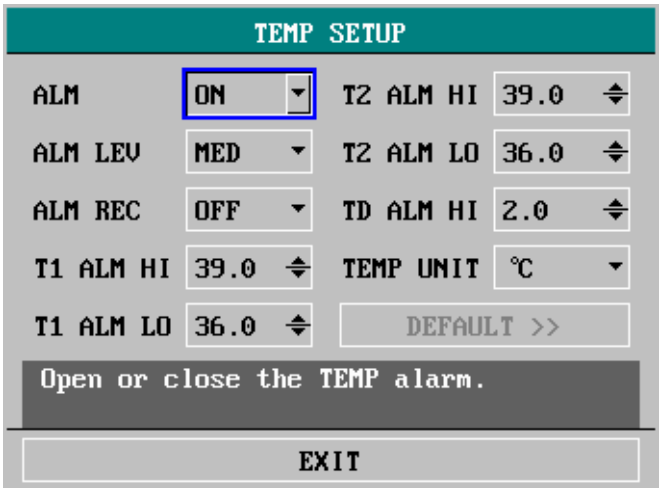


Figure 14-2 TEMP Setup Menu

You can perform the following settings in this menu.

- ALM — Temperature alarm on/off status
  ON: When a temperature alarm occurs, the monitor gives alarm indications and stores the alarm;
  OFF: When a temperature alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
  When OFF is selected, the icon is displayed on the right of the TEMP label.
- ALM LEV — Alarm level
  Options: HIGH, MED and LOW.
- ALM REC — Alarm recording
  ON: When a TEMP alarm occurs, the monitor enables the recording;
  OFF: When a TEMP alarm occurs, the monitor does not enable the recording.
- T1 ALM HI — Determines the upper alarm limit of temperature channel 1.
- T1 ALM LO — Determines the lower alarm limit of temperature channel 1.
- T2 ALM HI — Determines the upper alarm limit of temperature channel 2.
- T2 ALM LO — Determines the lower alarm limit of temperature channel 2.

- TD ALM HI — Determines the upper limit of the temperature difference between channel 1 and channel 2.
- TEMP UNIT — Options: ℃ and ℉
- DEFAULT >> — You can select this option to access the NIBP DEFAULT CONFIG menu, in which you may select FACTORY DEFAULT CONFIG or USER DEFAULT CONFIG. After finishing your selection and exiting the menu, the system pops up a dialog box asking for your confirmation.

Temperature alarm limits:

Parameter	Maxi. Upper	Mini. Lower	Step
T1 and T2	50	0	0.1
TD	50	0	0.1

14.4 Maintenance and Cleaning

⚠WARNING

- **Before cleaning the monitor or the probe, make sure the equipment is turned off and disconnected from AC power.**

Reusable Temperature Probes

- The temperature probe should not be heated to a temperature over 100℃ (212 ℉). It is only able to bear the temperature between 80 and 100℃ (176 to 212 ℉) for a short time.
- The probe must not be disinfected in steam.
- Only detergents containing alcohol can be used for disinfection.
- The rectal probes should be used, if possible, in conjunction with a protective rubber cover.
- To clean the probe, hold the tip with one hand and with the other hand rub the probe down in the direction of the connector using a moist lint-free cloth.

NOTE

- **Disposable temperature probes must not be re-sterilized or reused.**
- **Disposable temperature probes must be recycled or disposed of properly.**

15 IBP Monitoring

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15.1 Overview

The monitor provides two channels to measure the invasive blood pressure (IBP, including diastolic, systolic and mean pressures), and displays two waveforms.

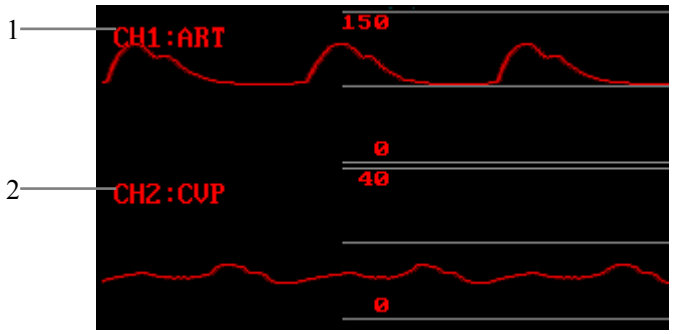


Figure 15-1 IBP Waveform

1. CH1 label: select the waveform of channel 1 to be displayed.
2. CH2 label: select the waveform of channel 2 to be displayed.

Options for CH1 and CH2: ART (Arterial Blood Pressure), PA (Pulmonary Arterial Pressure), CVP (Center Venous Pressure), RAP (Right Atrial Pressure), LAP (Left Atrial Pressure), ICP (Intracranial Pressure) and P1-P2 (Expand Pressure).

Besides, each waveform is followed by three scale lines, among which the upper and the lower ones are marked by scales on the left.

The parameter window locates to the right of the IBP waveforms as shown below.



Figure 15-2 IBP Parameter Window

1. IBP (1,2) label: This label allows you to access the IBP (1,2) SELECT menu.
2. Pressure unit: mmHg or kPa.
3. Parameter values of channel 1: Systolic pressure, mean pressure and diastolic pressure (from the left to the right).
4. Parameter values of channel 2: Systolic pressure, mean pressure and diastolic pressure (from the left to the right). When ART or ICP is selected for CH1 and CH2 respectively, the ICP and CPP values will be displayed, where CPP is equal to the mean pressure of ART minus ICP.

15.2 Precautions

⚠WARNING

- **Use only the IBP transducer specified in this operation manual. Disposable IBP transducers or domes should not be reused.**
- **Parts and accessories used must meet the safety requirements of the medical electrical equipment standards.**
- **The need for the operator to avoid conductive connection to the applied part likely to degrade safety. (For example, by not contacting metal cocks, if used.)**
- **When the monitor is used with high frequency surgical equipment, do not allow the transducer and the cable contact the high frequency surgical equipment to prevent the patient from burning caused by leakage current.**
- **Verify transducer cable fault detection before beginning to monitor. Unplug the transducer cable from the IBP connector on the monitor. The screen will display the error message "IBP SENSOR OFF" and an audible alarm will be heard.**

The transducer (except for the ICT/B transducer) specified in this operation manual is able to protect against electrical shock, especially the leakage current, and the interference of cardiac defibrillation. It can be used in surgical operation. During defibrillation, the pressure waveform might become temporarily distorted. However, the monitor returns to normal operation after the defibrillation, with the operation mode and the user configuration being unaffected.

NOTE

- **Periodically calibrate the transducer according to the Hospital Regulation.**

15.3 Monitoring Procedure

1. Plug the pressure cable into the IBP connector on the monitor and power on the monitor.
2. Prepare the pressure line and transducer by flushing the system with normal saline solution. Make sure the tubing and transducer system is free of air bubbles.

NOTE

- **In case of any entrapped air in the pressure system, re-fill the system with normal saline.**

3. Connect the catheter to the pressure line, making sure there is no air present in the catheter or pressure line.
4. Position the transducer so it is at the same level with the patient's heart, approximately mid-axillary line.
5. Verify the correct label is selected.
6. Zero the transducer.

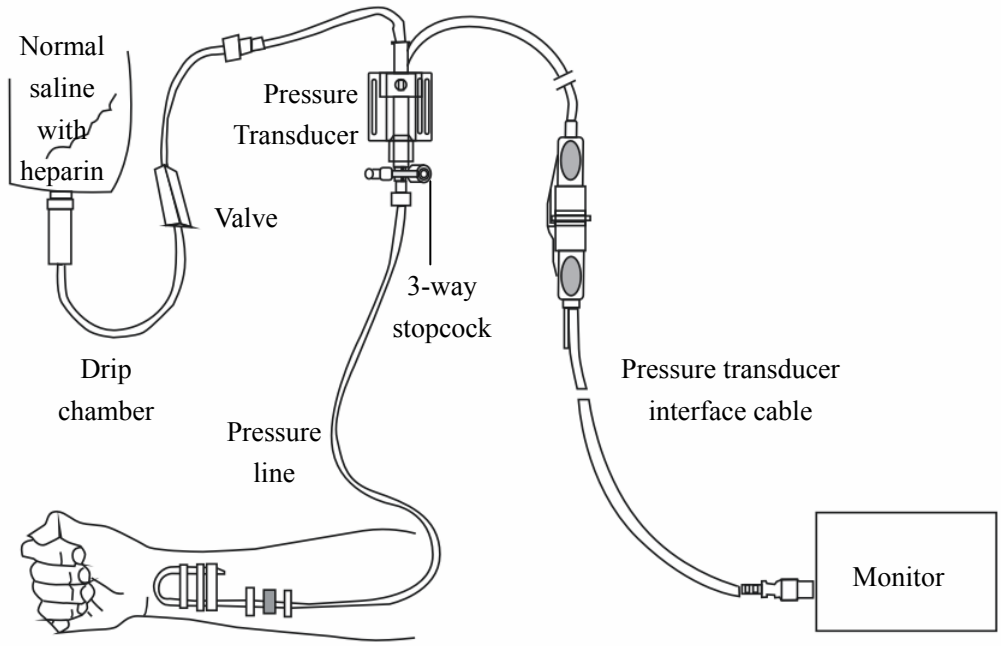


Figure 15-3 IBP Monitoring

15.4 IBP Menu

Selecting the IBP (1,2) label in the parameter window opens the following menu.

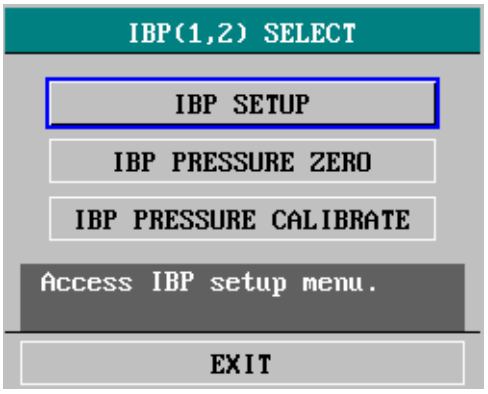


Figure 15-4 IBP (1,2) Select Menu

15.4.1 IBP Setup Menu

The IBP SETUP in IBP (1,2) SELECT menu allows you to access the following menu.

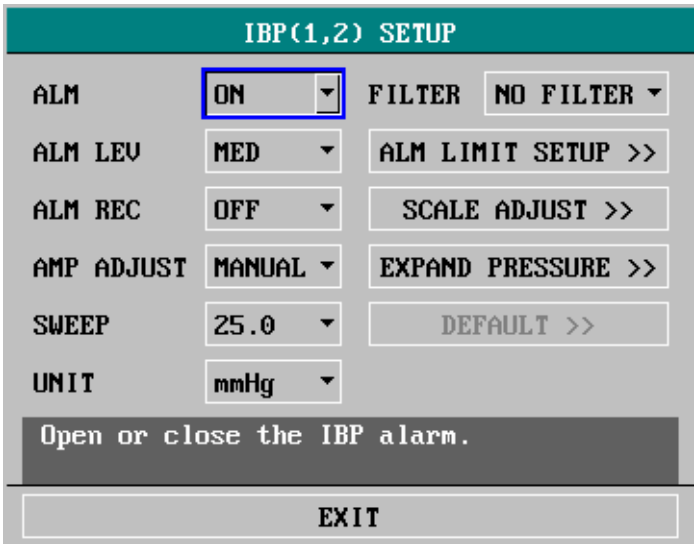


Figure 15-5 IBP (1,2) Setup Menu

You can perform the following settings in this menu.

- ALM IBP alarm on/off status
  ON: When a IBP alarm occurs, the monitor gives alarm indications and stores the alarm;

OFF: When a IBP alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
When OFF is selected, the icon is displayed on the right of the IBP (1,2) label.

- ALM LEV — Alarm level
  Options: HIGH, MED and LOW.
- AMP ADJUST — Amplitude adjustment
  This option allows you to adjust the waveform amplitude.
  Options : MANUAL and AUTO.

1. MANUAL: If MANUAL is selected, you can select an IBP channel manually from the options, including ART, PA, CVP, RAP, LAP, ICP, P1 and P2, and then adjust the IBP scale in the SCALE ADJUST >> menu.
2. AUTO: If AUTO is selected, the waveform labels of IBP channels become P1 and P2 and the IBP scale is adjusted by the system automatically.

- SWEEP — Waveform speed
  Options: 12.5 and 25.0 mm/s.
- UNIT — Options: mmHg and kPa.
- FILTER — This option allows you to select the filter method of the IBP waveform. Three options are available:
  NORMAL: 16Hz filtering;
  SMOOTH: 8Hz filtering;
  NO FILTER: Displays the original waveform.
  The default is NO FILTER.
- ALM LIMIT SETUP >> — This option allows you to access the following menu, whereby you can set the upper and lower alarm limits.

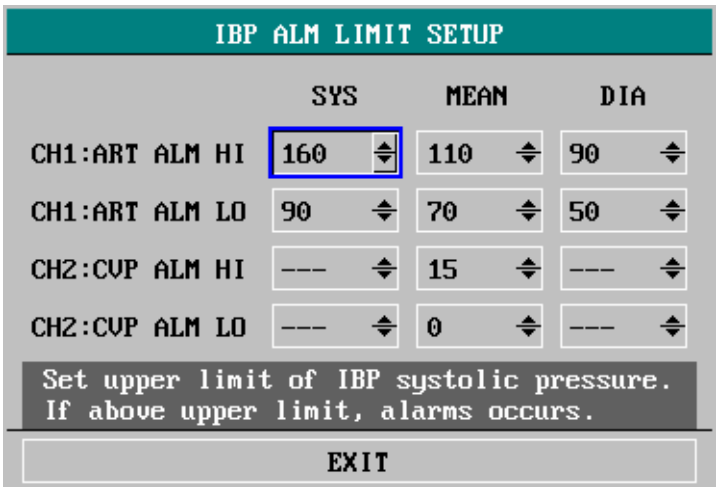


Figure 15-6 IBP Alarm Setup Menu

IBP alarm limits

Pressure Label	Max. Upper (mmHg)	Min. Lower (mmHg)	Step (mmHg)
ART	300	0	1
PA	120	-6	1
CVP	40	-10	1
RAP	40	-10	1
LAP	40	-10	1
ICP	40	-10	1
P1	300	-50	1
P2	300	-50	1

- SCALE ADJUST >> This option allows you to open the following menu and set the positions of the high, reference and low scales for the two waveforms.

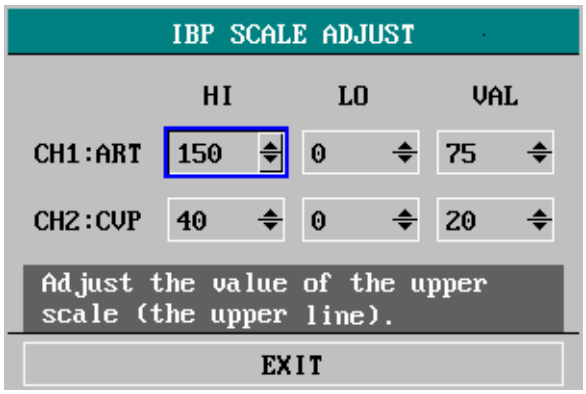


Figure 15-7 IBP Scale Adjust Menu

1. HI: Determines the high scale. The reference scale changes when the high scale is changed.
2. LO: Determines the low scale. The reference scale changes when the low scale is changed.
3. VAL: Determines the reference scale and position. The high and low scales remain unchanged when the reference scale is changed.

NOTE

- **The high scale should not be smaller than the low scale; the low scale should not be larger than the high scale.**
- **The waveform amplitude changes when the high and low scales are adjusted.**

- EXPAND PRESSURE — Selecting this option opens the following menu. You can select the pressure to be measured by P1 and P2. Options: SYS, MEAN, DIA (three pressures are all measured); MEAN (only the mean pressure is measured).

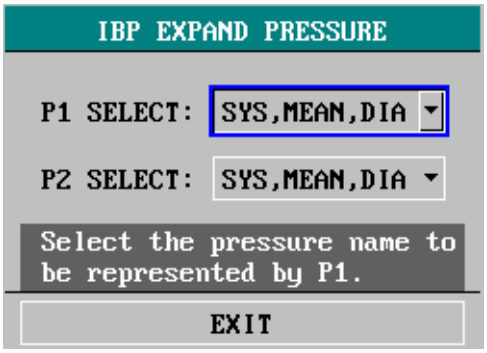


Figure 15-8 IBP Pressure Setup Menu

- DEFAULT >> — You can select this option to access the IBP (1,2) DEFAULT CONFIG menu, in which you may select FACTORY DEFAULT CONFIG or USER DEFAULT CONFIG. After finishing your selection and exiting the menu, the system pops up a dialog box asking for your confirmation.

15.4.2 IBP Pressure Zero Menu

You can select IBP PRESURE ZERO in IBP (1,2) SELECT menu to open the following menu.

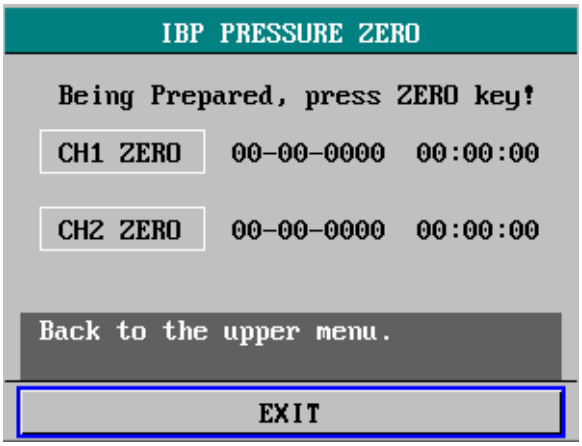


Figure 15-9 IBP Pressure Zero Menu

Pressure Transducer Zeroing Procedure

1. Disconnect the transducer from the patient.

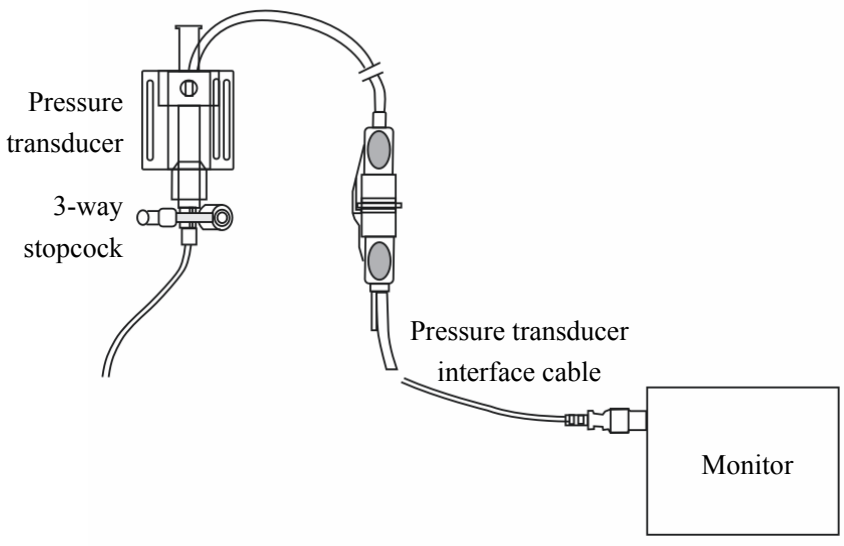


Figure 15-10 Pressure Transducer Zeroing

2. Adjust the 3-way stopcock to close the channel leading to the patient. The transducer is open to the atmosphere through the stopcock.
3. Select CH1 ZERO or CH2 ZERO in IBP PRESSURE ZERO menu to start zeroing.

NOTE

- **To ensure correct measurement, zero the transducer before it is used to zero the monitor.**
- **Position the transducer at the same level with the patient's heart, approximately mid-axillary line.**
- **Perform the pressure zeroing before monitoring, and at intervals during monitoring (at least once per day). The zeroing should also be conducted once the transducer cable is disconnected and then connected.**

Prompt Information Related to Zeroing

Take channel 1 as an example. The monitor may give the following prompt information after the pressure transducer zeroing has been finished.

- CH1 SUCCESSFUL ZERO

The zeroing procedure is over. The transducer port opening to the atmosphere is to be closed and the port connecting to the patient opened.

- CH1 SENSOR OFF, FAIL

Verify the transducer of channel 1 is connected to the monitor, and then perform zeroing again. If the monitor continues to give this prompt information, contact our Customer Service.

- IN DEMO, FAIL

Make sure the monitor is not in DEMO mode, and perform pressure transducer zeroing again. If the monitor continues to give this prompt information, contact our Customer Service.

- PRESSURE OVER RANGE, FAIL

Verify the 3-way stopcock is open to the atmosphere, and perform the pressure transducer zeroing again. If the prompt information is still displayed, change with a new transducer and contact our Customer Service.

- PULSATILE PRESSURE, FAIL

Make sure the transducer is not connected to the patient and the stopcock is open to the atmosphere. Then, perform the pressure transducer zeroing once again. If the prompt is still displayed, contact our Customer Service.

15.4.3 IBP Pressure Calibration

You can select IBP PRESSURE CALIBRATE in IBP (1,2) SELECT menu to open the following menu.

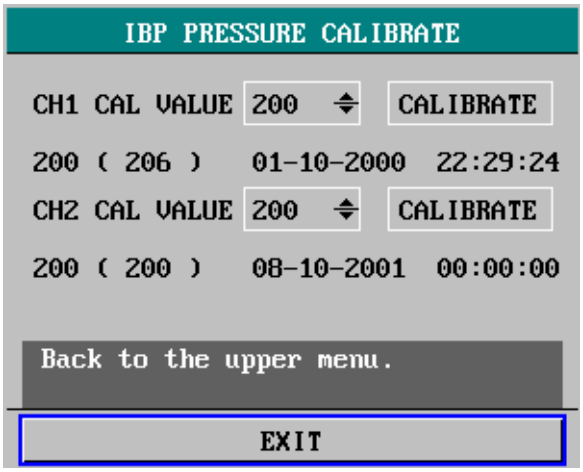


Figure 15-11 IBP Pressure Calibration Menu

Calibration Procedure

1. Disconnect the pressure transducer from the patient. Connect the 3-way stopcock, the sphygmomanometer and the inflation orb, using a T-shape connector, as shown below.

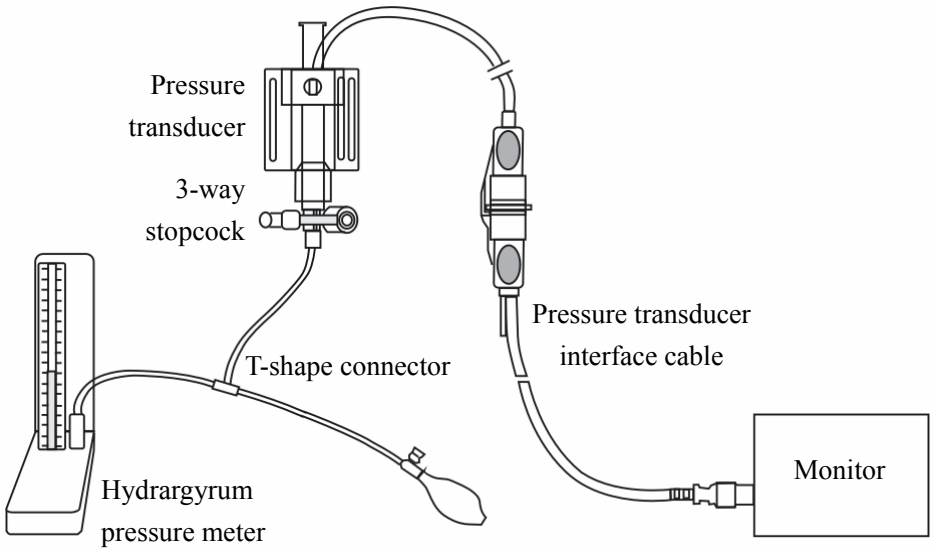


Figure 15-12 IBP Pressure Calibration

2. Perform the pressure transducer zeroing beforehand. If the zeroing succeeds, open the stopcock to the sphygmomanometer.
3. In the IBP PRESSURE CALIBRATE menu, select a value from the CH1 CAL VALUE or the CH2 CAL VALUE popup menu. The calibration pressure value of channel 1 or channel 2 is set.
4. Inflate using the inflation orb, until the mercury volume of the sphygmomanometer rises to the preset calibration pressure value.
5. Adjust the preset calibration value repeatedly until it is the identical to the pressure value indicated the mercury column.
6. Select CALIBRATE in IBP PRESSURE CALIBRATE menu. The monitor starts calibrating.
7. Wait for the calibration result. Take actions in response to the prompt information given by the monitor.
8. After the calibration, disassemble the blood pressure tubing and the T-shape connector. Then, connect the pressure transducer with the patient, as directed, for normal monitoring.

NOTE

- **Perform the calibration prior to the use of a new transducer, or at intervals according to the hospital regulation.**
- **The calibration ensures accurate measurement of the monitor. The pressure transducer zeroing should be conducted before the calibration.**

⚠WARNING

- **Never perform the calibration during patient monitoring.**

Prompt Information Related to Calibration

Take channel 1 as an example. The monitor may give the following prompt information after the calibration has been finished.

- CH1 SUCCESSFUL CALIBRATE

Channel 1 works normally and can be applied to IBP monitoring.

- CH1 SENSOR OFF, FAIL

Verify the transducer of channel 1 is connected to the monitor, and then perform the calibration again. If the monitor continues to give this prompt information, contact our Customer Service.

- IN DEMO, FAIL

Make sure the monitor is not in DEMO mode, and perform the calibration again. If the monitor continues to give this prompt information, contact our Customer Service.

- PRESSURE OVER RANGE, FAIL

Verify the preset calibration value is reasonable, and perform the calibration again. If the prompt information is still displayed, contact our Customer Service.

- PULSATILE PRESSURE, FAIL

Verify the pressure value indicated by the sphygmomanometer keeps unchanged, and then perform the calibration again. If the prompt information is still displayed, contact our Customer Service.

15.5 Maintenance and Cleaning

⚠WARNING

- **Before cleaning the transducer, make sure the transducer is disconnected from the monitor, or the monitor is powered off and disconnected from AC power.**

Cleaning of IBP Transducer

After the IBP monitoring operation is completed, remove the tubing and the dome from the transducer and wipe the transducer diaphragm with water. To clean the transducer and the cable, wipe them using soap or the detergents listed below:

- Cetylcide
- Wavicide-01
- Wescodyne
- Cidex
- Lysol
- Vesphene

Do not immerse the connector in any liquid. After cleaning, dry the transducer thoroughly before storing. Slight discoloration or temporary increase of surface stickiness of the cable should not be considered abnormal. If it is necessary to remove the adhesive tape residue from the transducer cable, the double seal tape remover is recommended; use the remover with special caution to minimize the damage to the cable. Acetone, Alcohol, Ammonia and Chloroform, or other strong solvents are not recommended because they are harmful to the vinyl cabling if used for a long time.

NOTE

- **The disposable transducers or domes must not be reused.**
- **To avoid contamination, the disposable transducers or domes must be reclaimed or disposed of properly.**

Sterilization

- Chemical Solution Sterilization

After finishing the cleaning, select an effective sterilant for chemical solution sterilization of the operating room equipment. Buffered glutaraldehyde (e.g. Cidex or Hospisept) is recommended. Do not use quaternary cationic detergents such as zephiran chloride. If the whole unit is to be sterilized, immerse the transducer but not the electrical connector into the sterilant for the recommended sterilizing period. Ensure that the dome has been removed. Then rinse all transducer parts except the electrical connector with sterilized water or saline. The transducer must be thoroughly dried before storing.

- Gas Sterilization

For more complete asepsis, use gas sterilization. The transducer should be completely dry after cleaning. When ethylene oxide gas is used as the gas disinfectant, follow the operating instructions provided by the manufacturer of the gas disinfectant.

NOTE

- **The disinfectant temperature must not exceed 70°C (158°F). Plastics in the pressure transducer may deform or melt above this temperature.**

15.6 ICP Transducer ICT/B

15.6.1 Introduction

The ICT/B is one of catheter tip transducers manufactured by Gaeltec. It is designed for measuring intracranial pressure by the epidural method. It features quite a few advantages, like ease-to-use and excellent frequency response without artifacts.

The ICT/B has an atmospheric reference pressure channel that connects the back of the sensing area to the ambient air pressure via the luer fitting on the connector. All measurements are the difference value compared with ambient air pressure.

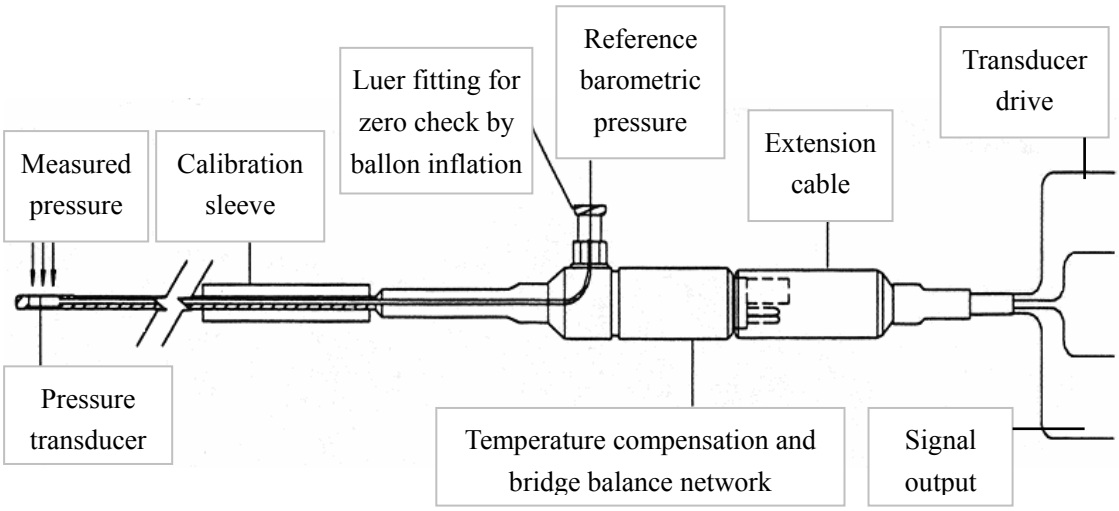


Figure 15-13 ICT/B Transducer

A significant feature of the ICT/B is the ability to check the zero drift of the ICT/B and pressure monitor in-vivo. Not only does this allow accurate measurements, but also allow the moving of the patient with the ICT/B in the epidural space and easy reconnection to another monitor.

There is a flat silicone rubber membrane, or balloon, covering the pressure sensing diaphragm. Two internal tubes connect the two sides of the diaphragm to a female luer fitting on the connector shell. By introducing approximately 0.2 to 0.3ml of air from a 1ml syringe the pressure in these tubes will be greater than the ICP being measured. The exact amount of air is not critical if only it does not exceed the permitted maximum. When this air is injected, the pressure will cause the balloon to be lifted from the surface of the sensor and the same pressure will be applied to the back of the sensor. The strain gauge senses equal pressure above and below which is equivalent to having zero pressure applied. Thus by injecting a small volume of air, one can correct the offset of the pressure transducer and check the zero of the transducer and amplifier.

15.6.2 Precautions

NOTE

- **The ICT/B pressure transducer is specially designed to be used by trained professional physicians. Operation on the transducer is restricted to the well-trained physicians only.**
- **The monitor using the ICT/B pressure transducer must meet the current safety standards of the country, where the monitor is or is to be used, and should be able to work with the strain gauge pressure transducer. The monitor must provide electrical isolation from the transducer and any electrical equipment to which the monitor is connected.**
- **Carefully check for cuts on the silicone of the catheter and sensor tip before use.**
- **When placing the ICT/B transducer, the burr hole edges must be rounded and the bone chips must be removed, so as to insert the catheter into the epidural space in an "S" bend. The catheter should be protected in the position of the sutures, to avoid any damage to the catheter when pulling sutures tight. When removing the catheter, special caution should be taken to avoid damaging the device while cutting sutures. Slowly pull the catheter to remove the ICT/B transducer.**

⚠CAUTION

- **Do not use haemostats or forceps that might damage the device.**
- **Do not press with thumb and forefinger on the tip of the ICT/B. Enormous pressures will be generated and the device will be subject to possible damage. To see if the ICT/B is operating normally, gently touch the sensor tip.**

⚠WARNING

- **Disconnect the catheter from the monitor before defibrillation or electrosurgery.**
- **Do not plug the female luer on the proximal end of the catheter during ethylene oxide sterilization. Otherwise, damage to the transducer may be caused.**
- **Do not immerse or soak the electrical connector end in any fluid or liquid.**

15.6.3 Calibration and Zeroing

Calibration

The ICT/B is supplied with a minimal zero offset and the sensitivity is set at 5 uV/V/mmHg. To ensure accurate settings of the amplifier and recorder, the controls should be zeroed at ambient pressure and then calibrated at a known pressure. For instance, use the calibration tube, syringe and manometer, or immerse it into a known depth of water column and then set the gain of the system to the required level. The procedure above should be performed once again to verify the zero baseline does not changed due to the gain change.

Tighten the collet on the calibration tube over the sliding calibration sleeve to seal the ICT/B catheter. Use a male luer fitting to form a connection to a reference pressure, such as a syringe and manometer. The output of the transducer and amplifier system can be reliably and quickly confirmed.

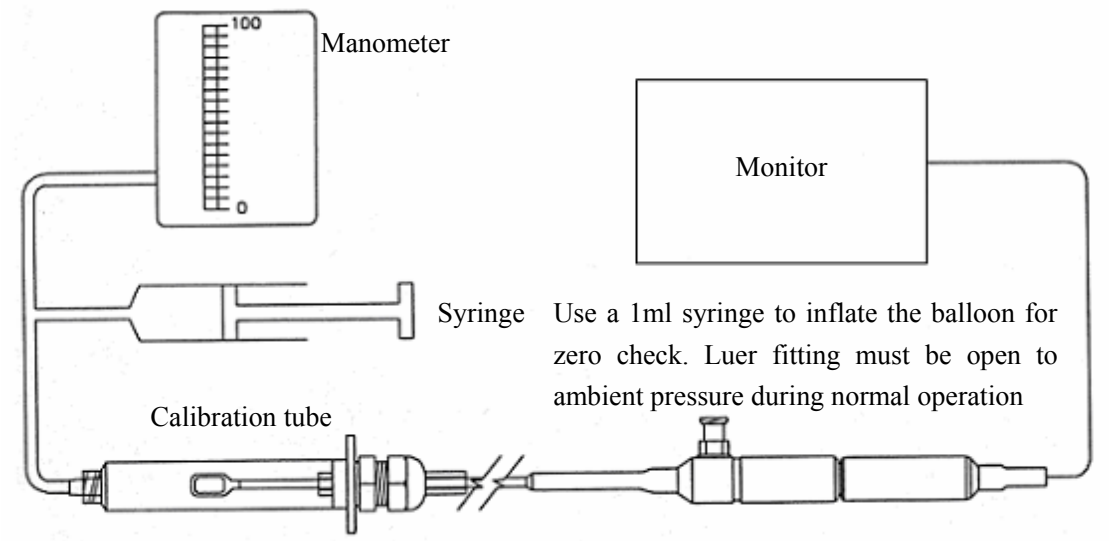

100
0
Manometer
Monitor
Syringe
Use a 1ml syringe to inflate the balloon for zero check. Luer fitting must be open to ambient pressure during normal operation
Calibration tube

Figure 15-14 ICT/B Calibration

Zeroing

- Checking the Zero when the ICT/B is in the Epidural Space

Using a 1ml syringe, inject approximately 0.3cc of air into the female luer connector on the proximal end of the ICT/B. Leave the syringe attached and note the value on the pressure monitor or scope. The ICP will decrease to zero or a value very close to it. If the monitor/transducer combination has drifted from zero, reset the zero control to zero value on the meter. Remove the syringe and the monitor will immediately begin to measure intracranial pressure.

⚠CAUTION

- **The total volume of air injected from a 1ml syringe to check the zero must not exceed 0.5ml. Otherwise, the membrane over the sensor might be ruptured.**

■ Connecting to a new monitor when the ICT/B is in the Epidural Space

1. Set correct pressure range on monitor.
2. Inject 0.3cc air from a 1ml syringe.
3. Adjust the monitor for zero reading.
4. If applicable, continue injecting air and set the calibration number on the monitor.
5. Remove the syringe and the ICP is displayed immediately.

Before clinical application, it is recommended to connect the ICT/B with the monitor and practice operating the equipment to familiarize the operation. Set up the monitor and the ICT/B as already described. Use either a water column or the calibration tube to apply a known pressure of from 10 – 25mmHg to the ICT/B. Note that a 13.6cm water column is equivalent to 10mmHg.

With the known pressure applied to the ICT/B, inject approximately 0.3cc air into the female luer using a 1ml syringe. Note that the monitor does not reach zero immediately. When the ICT/B moves rapidly up and down in a water column, the pressure waveform changes instantly. The ICT/B has a high frequency response. Thus you will see excellent pressure waveform in actual operation. It also reflects that the exact amount of air injected for zeroing is insignificant.

NOTE

- **Always leave the luer fitting open to the ambient pressure during measurement.**

15.6.4 Application of ICT/B

NOTE

- **ICT/B transducer must be used under supervision of qualified physician.**

The ICT/B is intended for the measurement of epidural pressures. It can measure positive pressures only. Thus, it is not recommended to measure intraventricular pressures. The ICT/B may be applied using a variety of surgical techniques. Therefore, surgeons are advised to choose the best way according to their knowledge and experience.

■ Method 1

The ICT/B can be inserted during surgery through a burr hole. The pressure sensor of the transducer should be placed facing the dura and under the cranium. The transducer is marked by 2.5cm scale on its back. Thus the scale is visible if the sensor is placed correctly. The placement site should be away from any craniotomy flap. A contralateral burr hole is recommended.

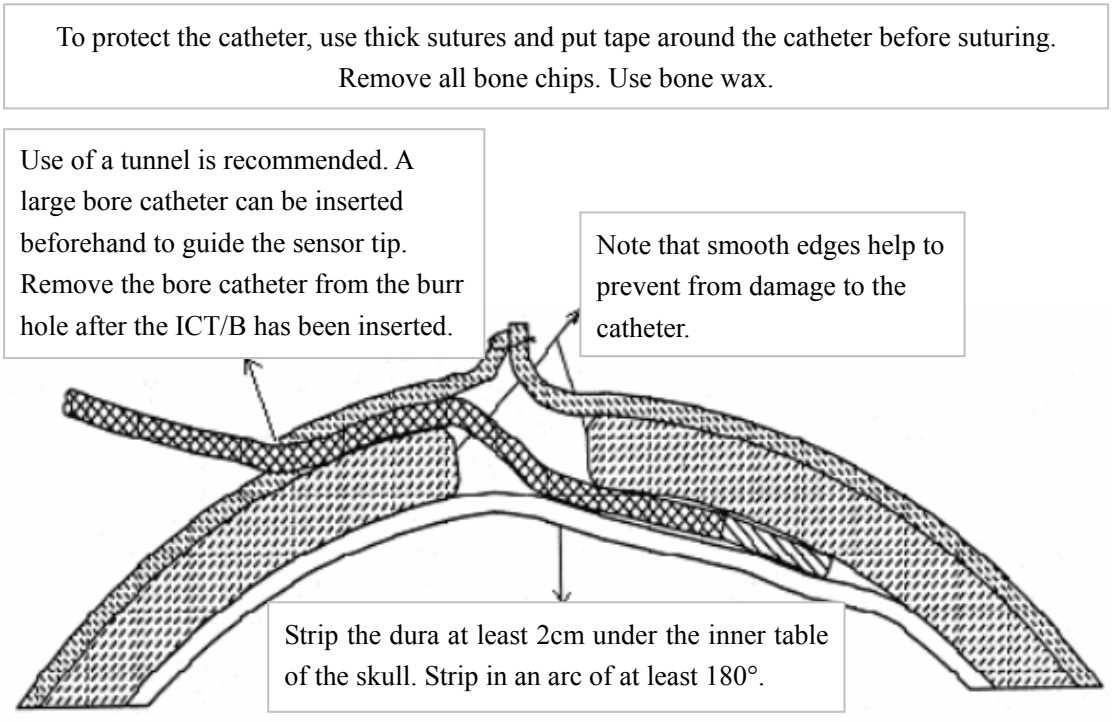

To protect the catheter, use thick sutures and put tape around the catheter before suturing. Remove all bone chips. Use bone wax.
Use of a tunnel is recommended. A large bore catheter can be inserted beforehand to guide the sensor tip. Remove the bore catheter from the burr hole after the ICT/B has been inserted.
Note that smooth edges help to prevent from damage to the catheter.
Strip the dura at least 2cm under the inner table of the skull. Strip in an arc of at least 180°.

Figure 15-15 Application of ICT/B

The dura mater should be carefully stripped at least 2cm under the skull and 180° in arc before insertion. Failure to do this will result in wedging of the pressure sensor and inaccurate readings. Reseat the transducer tip after a few days since the dura may rapidly tighten and change its physical characteristics.

If possible, round the bone at the point where the catheter makes its first bend into the burr hole and round the bone where the catheter makes the second bend under the cranium. This helps to prevent from tearing the catheter or tip during insertion or removal. In case of a tear of the catheter, the catheter must be returned to the manufacturer for repair, incurring a lot of inconveniences.

The catheter is led out through the wound through a drain. It may make sharp bends without disturbing the operation of the ICT/B. Care should be taken though, to avoid pinching the catheter by bending onto itself at acute angles for this will seal and possibly damage the internal lumens required for proper operation.

The catheter should be restrained from moving once the tip is in place. It may be fixed to the scalp by encircling sutures or with a silicone rubber suture collar provided by the manufacturer, such as the peritoneal shunt systems. The latter method is preferred, as it will help prevent from damage to the catheter by sutures or during removal of sutures.

- Method 2

First send the catheter to the burr hole through a tunnel under the skin (a small incision is made on the skin, and the catheter enters the tunnel from a point distal to the burr hole). The ICT/B can be guided in the tunnel by a disposable tube, which can be removed afterwards from the burr hole. This method is preferred from both a mechanical stability point of view and from the low incidence of infection. The catheter can later be removed in the manner of a drain and the burr hole incision sutured.

The physician is urged to examine the ICT/B for physical damage to the silicone rubber covering anywhere on the tip or catheter before use. In case of any damage, do not use the catheter and return it to the manufacturer for repair. Proper function should be verified before insertion into the epidural space, by gently touching the tip of the transducer and observing a pressure change displayed the monitor. Once the ICT/B has been inserted into the epidural space, the physician should check the proper function again, by injecting 0.3cc air for zeroing of the ICT/B. The monitor should respond correctly as described above.

- Summary

1. When preparing the burr hole, it is required that the hole be rounded at the edges where the catheter is inserted with an "S" bend into the epidural space.
2. Remove all bone chips
3. A small pledgelet of woven bandage should be placed around the catheter at the position of sutures. This prevents damages to the catheter when pulling sutures tight. Otherwise the catheter will be easily cut.
4. Use some bone wax on the edges of bone where the catheter and tip make contact with bone.
5. When removing the catheter, special attention should be paid to avoid damaging the device while severing the sutures. Remove the ICT/B by slowly pulling the catheter.
6. The dura mater should be stripped to give sufficient space so that the tip of the sensor is inserted easily.
7. Do not use haemostats or forceps that might damage the device. Do not squeeze the sensor with the thumb and the forefinger.

15.6.5 Maintenance and Cleaning

⚠WARNING

- **The ICT/B is supplied non-sterile. It must be cleaned and sterilized each time before use.**
- **Do not autoclave; do not use radiation sterilization or ultrasonic cleaning.**
- **Do not use the sterilizing cap during ETO gas sterilizing.**
- **Do not use chlorinated hydrocarbons, toluene, or sodium hypochlorite solution for disinfection.**

Right after the catheter is removed from the patient, check the silicone coating for damage. Use a 1ml syringe to inject 0.5cc air into the luer and immerse the catheter in water. If small bubbles are seen from any part of the catheter or tip, dry the catheter by a cloth and sterilize. Then, return to the manufacturer for repair.

Inspect for cuts or damage to silicone coating before immersing it in any liquid. Avoid getting liquid on the connector pins or inside the connector via the luer fitting. Wash the catheter with soap solution. Avoid damaging the sensing area. Do not use synthetic detergents or oil-based soaps as this may result in a foreign body reaction.

Transducers may be cleaned gently with alcohol. But, do not soak it in alcohol. The cold aqueous solutions of detergicide (e.g. Cidex), formalin or by ethylene oxide gas can be used for disinfection.

NOTE

- **It is recommended that each institution establish a sterilization procedure to specify what products are to be disinfected.**
- **There are only two chemical sterilization techniques recognized by the U.S. Department of Agriculture as effective and truly sporicidal, gas sterilization by ethylene oxide and liquid sterilization by a glutaraldehyde.**

Ethylene oxide (ETO) Disinfection Procedure

1. Unplug the female luer on the proximal connector before the ETO disinfection cycle. Failure to do this will result in damage to the ICT/B or even disable it.
2. The luer must be open to allow the incoming and the outgoing of ETO gas.
3. Coil the ICT/B and put it in a package filled with ETO. The package shall be indicated by an approved disinfection mark.
4. Disinfection—The disinfection procedure should be accepted by the hospital staff responsible for disinfection. Follow the manufacturer's instructions for disinfection.

Use the following as a guide only. According to the hospital regulations on disinfection, the qualified ETO disinfection parameters are listed below.

- Sterilizer make and mode AMSCO Eagle 2000
- Prevacuum 15 minutes, 24 inches Hg
- Relative humidity 40%
- Temperature 140˚F
- ETO mix 12:88
- Gas pressure 8 Pa
- Exposure time 1 hour and 45 minutes
- Post Vacuum 15 minutes, 24 inches Hg
- Aeration Cycle 12 hours
- Calculated ETO Concentration 600mg/l

Liquid Disinfection Procedure

To prevent liquids from entering the female luer on the electrical connector, a male plug may be used. But this plug must be removed during normal use and the ETO disinfection.

1. Rinse and soak the catheter transducer in the glutaraldehyde solution, following the instructions provided by manufacturer of the chemical agent. Note that disinfection is not equivalent to sterilization, and you must refer to the manufacturer’s instructions to see the effect of the glutaraldehyde solution.
2. Before using the disinfected catheter transducer, rinse with pyrogen-free, sterile distilled water or saline solution recommended by the disinfectant manufacturer.

Precautions

The metal sensor is robust and can withstand severe shocks and vibrations. However, it cannot be recovered if damaged by sharp objects or overpressure, for instance by squeezing the tip using the forefinger and the thumb.

The silicone coating on the sensing area allows a small amount of water absorption. But if the water absorption lasts for an hour or more, the baseline may drift several mmHgs. In this case, put the device in water or saline solution for a few hours to stabilize before use.

Liquids entering the back of the sensor will cause damage to the sensor. Cutting on the outer coating should be avoided and repaired immediately once detected. You may return it to the manufacturer or apply a temporary repair using a suitable silicone sealant to the damage.

The most common reason for failure of the ICT/B pressure transducer is physical damage to the device's silicone catheter and/or tip. The cuts are usually caused by sharp bone chips or edges and are not always visible to the naked eye. If such damage remains undetected, fluids may enter the device and damage the sensing parts.

15.6.6 Frequently Asked Questions

15.6.6.1 Questions and Answers

Questions	**Answers**
Is the ICT/B a single use device?	No, it can be reused.
If it is damaged, what shall we do?	Disinfect first. Then, send it together with the purchase order back to the manufacturer for repair.
Does the air used for checking the zero get into the patient?	No. Air used for checking the zero stays in the fine lumens and tip of the ICT/B until the syringe is removed.
What happens if we autoclave the ICT/B?	It must be sent to the manufacturer for repair.
We inject air to check the zero but the baseline on the scope always returns to ICP even if we leave the syringe attached. What's the reason?	There is a leak in the catheter or sensor tip. Remove, wipe clean with alcohol and then disinfect. Return the device to the manufacturer for repair.
Readings were taken with the syringe left attached until we noticed it. Can we rely on these readings?	No. They are incorrect. All pressure readings must be made with the proximal female luer open to atmosphere.
A new staff injected water into the luer. Though we found it immediately, some water went into the ICT/B. Is the device ruined?	Probably not. Return it to the manufacturer for repair.
Why is the ICT/B damaged if we perform ETO disinfection with the luer blocked?	When you plug the luer you are sealing the internal lumens at normal atmospheric pressure. Part of the ETO cycle is a partial vacuum. Thus, the trapped air at atmospheric pressure will expand and rupture the balloon.

15.6.6.2 Troubleshooting

Trouble	Cause	Solution
When you inject air to zero and calibrate the device, the baseline reappears with the waveform displayed.	The catheter or tip is cut and cannot hold zero for a long time.	The readings are unreliable. Remove the ICT/B and use a spare. The waveforms will be displayed correctly.
The monitor indicates ‘damaged gauge’ or ‘over range’. No matter you inject air or not, you cannot see the waveform.	Either the tip is ‘wedged’ or the tip sensor was over-pressured against the dura during insertion. Therefore the monitor detects a transducer that has a very high initial zero and finds this zero out of its range.	If the tip is wedged, pull back a few millimeters to free it. This will allow the monitor to be zeroed. If the above action does not help, the transducer must have been damaged. Remove the transducer and return it the manufacturer for repair. Sometimes raising the scale of the monitor requires a high zero offset. Try raising the pressure scale to 90, 120 or 300mmHg and then zero. This solution may work but the waveform resolution will be compromised. It is recommended to return the catheter for repair when the measurement is finished.
When everything runs normally, the ‘damaged gauge’ or ‘over-range’ light suddenly starts flashing.	Although over-pressured or wedged, the sensor zero must have been just within the range of the monitor. As conditions changed, the total pressure (=zero amount+ICP) pushed the monitor beyond its measurement range.	Try raising the pressure scale to 90, 120 or 300mmHg and then zero.
The transducer can be zeroed and we have good pressure waves, but the ICP reading always remains around zero mmHg.	The sensor face must be flat (planar) against the dura. If its facing the inner table of the skull, you will get pressure waves and be able to zero it but not obtain actual ICP readings. The sensor may be placed	It is important that the transducer face be placed against an intact section of dura. If required, use a contralateral burr hole.

	properly, but the brain may have moved far away from the skull so that there is poor contact between the skull, the transducer and the dura. This may happen soon after the transducer is placed, but the transducer can correct itself in a short time.	
The monitor displays good waveforms, but the ICP reading is negative.	Improper zeroing.	The ICT/B cannot read negative pressure. Rezero the monitor /transducer combination. Make sure that the female luer is not blocked when the readings is measured.
The waveform on the monitor makes large periodic fluctuations.	If you are using a respirator or some device that applies pressure even indirectly, the ICP might be affected. The transducer normally can reflect the pressure change.	/

16 CO Monitoring

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16.1 Overview

- The Cardiac Output (C.O.) measurement is performed using thermodilution method.
- The monitor is able to measure the patient's blood temperature and cardiac output, and perform hemodynamic calculation.
- You can choose either the ambient temperature injection or ice-water injection, using the injection system or a syringe.
- You can perform up to six measurements before calculating the average cardiac output (C.O.) and the average cardiac index (C.I.).
- Prompt information displayed on the screen guides you to perform the measurement step by step.

The CO measurement only produces some parameter numerics in the parameter window, but gives no waveform. See the CO parameter window as follows.

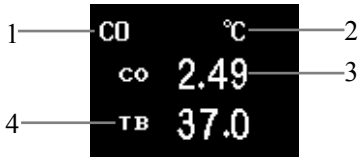


Figure 16-1 CO Parameter Window

1. CO label: This label allows you to access the CO SETUP menu.
2. Temperature unit: ℃ or ℉.
3. CO: The measured cardiac output.
4. TB: The measured blood temperature.

16.2 Measurement Procedure

⚠WARNING

- **The accessories applied must meet the safety requirements for medical instruments.**
- **When the accessories are in use, avoid contacting conductive metal objects.**

The following is the procedure to monitor patient's cardiac output.

1. Connect the CO cable into the CO sensor connector of the monitor.
2. Connect the CO measurement catheter and the temperature probe correctly as shown in Figure 16-2. The blood temperature reading is displayed.
3. Open the C.O. SETUP menu and adjust the parameters contained in this menu.

⚠WARNING

- **Make sure that the computation coefficient for the measurement (CO.CONST, see *16.3 CO Setup Menu* for details) is appropriate to the catheter used.**

NOTE

- **If the catheter is to be replaced, follow the instructions for the catheter and input its calculation coefficient into the CO.CONST field in the CO setup menu.**

4. Select the CO label in the CO parameter window, and the CO SELECT window pops up. Then, select C.O. MEASURE to open the WINDOW FOR C.O. EDIT menu.

NOTE

- **Set the injectate temperature source properly in the CO setup menu. The ON/OFF state of the injectate temperature source, when measurement is finished, affects the CO calculation. Thus, do not change the injectate temperature source before the measurement is over.**

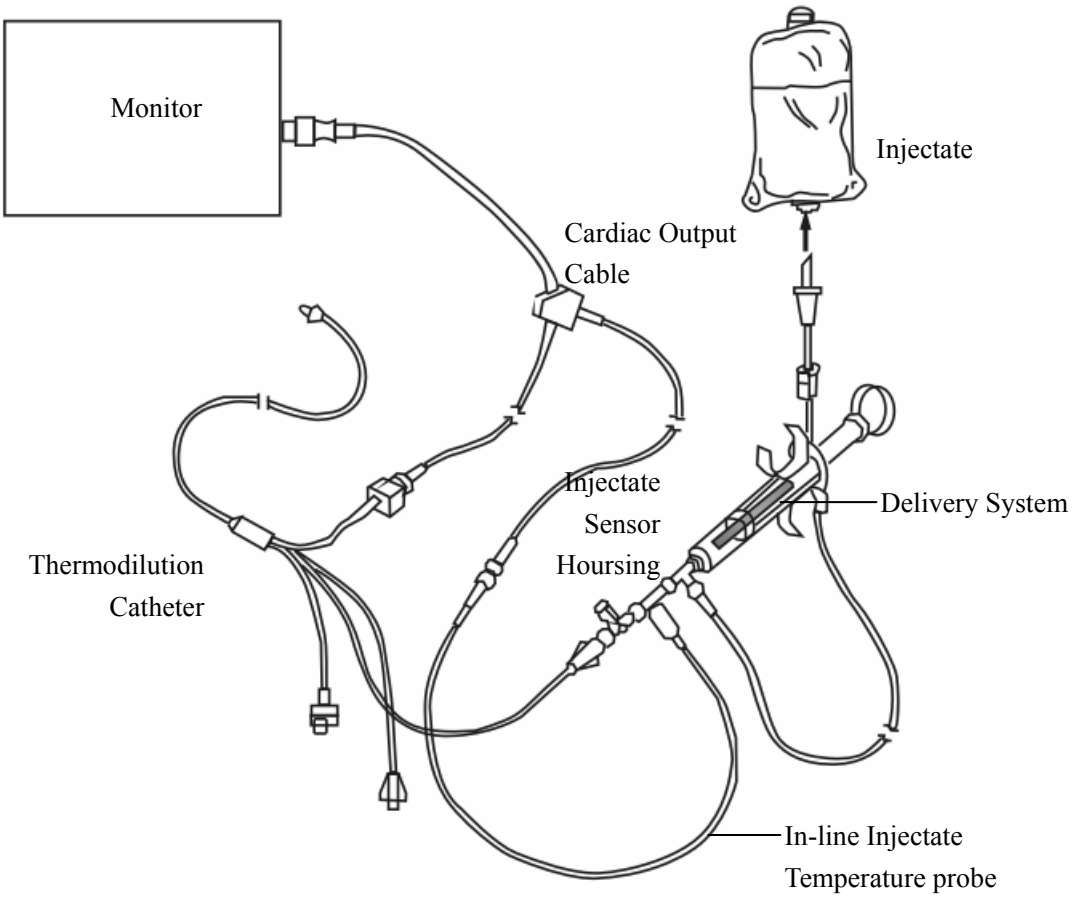


Figure 16-2 CO Sensor Connections

5. You may repeat the measurement if necessary.
6. When measurement(s) is finished, open WINDOW FOR C.O. EDIT to edit the measured data. The rest of the sections include detailed procedure of editing.

NOTE

- **The blood temperature alarm is disabled during CO measurement. It will be re-enabled when the measurement is over.**

16.2.1 Window for CO Measurement

Selecting the CO label in the CO parameter window opens the CO SELECT menu. Then, select the CO MEASURE option to access the WINDOW FOR CO MEASUREMENT. If the CO sensor is not connected, “No sensor, unable to measure C.O.” will be displayed in the prompt information area of the window.

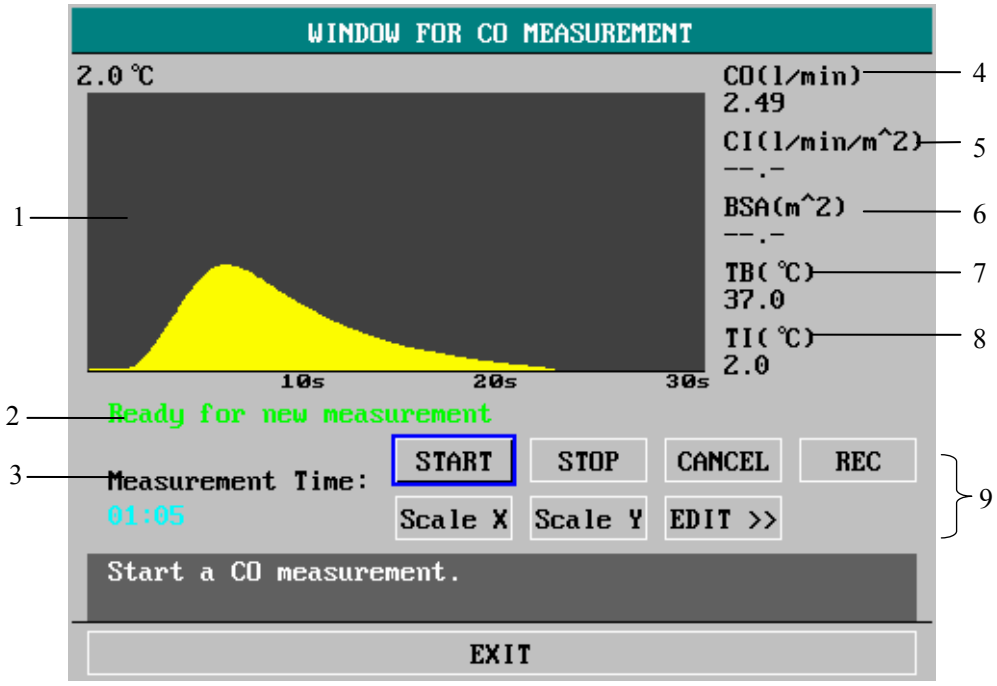


Figure 16-3 Window For CO Measurement

1. CO measurement curve
2. Prompt information
3. Measurement start time
4. CO: measured cardiac output
5. CI: cardiac index
6. BSA: body surface area
7. TB: temperature of blood
8. TI: temperature of injectate
9. Function options in the window. Details about the function options are given below.

- START — Selecting this option starts a measurement.
- STOP — In the process of the CO measurement, if the blood temperature cannot restore to its initial value for a long time and the measurement cannot stop automatically, you may

select this option to stop the measurement. The measured CO and CI will be displayed.

- CANCEL — Selecting this option during a measurement cancels the measurement. Selecting it after a measurement deletes the measurement result.
- REC — This option allows you to print the measurement curve using the recorder.
- Scale Y — This option allows you to change the scale of Y-axis (temperature).
  Three levels: 0 - 0.5℃, 0 - 1℃ and 0 - 2.0℃.
  You can adjust the scale according to the temperature difference. The smaller the scale is, the larger the curve will be.
- Scale X — This option allows you to change the scale of X-axis (time).
  Two levels: 0 - 30S and 0 - 60S.
  If you start measurement in the 0 - 30s level, it will be switched to 0 - 60s level automatically if the measurement cannot be finished within 30 seconds. After the switch, no further adjustment can be made to the X-axis.
- EDIT — This option allows you to enter WINDOW FOR C.O. EDIT.
- EXIT — This option allows you exit WINDOW FOR CO MEASUREMENT.

Measurement Procedure

1. The cardio output measurement can be started when the prompt information “Ready for new measurement” appears in the window.
2. Select the START option, and then start the injection.
3. The thermodilution curve, the current blood temperature and the injectate temperature are displayed in the process of the measurement.
4. The curve drawing stops automatically when the measurement is completed. At the same time, the C.O. (Cardiac output) and the C.I. (Cardiac Index) are calculated and displayed in the window. The monitor also displays the CO value in the CO parameter window.

To ensure the accuracy of the measurement, it is suggested two consecutive measurements be performed at an interval. The length of the interval can be set in the C.O. SETUP menu (time unit: second). The remaining time to the next measurement is displayed at the position of 2 in Figure 16-3. The next measurement cannot be performed until the time reduces to zero and the “Ready for new measurement” prompt information appears.

NOTE

- **You must perform the injection within 4 seconds after pressing the START option.**
- **You are recommended to wait for 1 minute or longer, depending on the patient's clinical condition, before starting the next measurement.**

You can perform a maximum of 6 measurements before editing. If extra measurements are performed, the latest measurements will replace the earlier ones. If a curve in the editing window is not selected for calculation (excluded from the averaging calculation), the place of the curve will be taken by the new measurement result.

CO Editing

Selecting EDIT >> from WINDOW FOR C.O. MEASUREMENT opens WINDOW FOR C.O. EDIT.

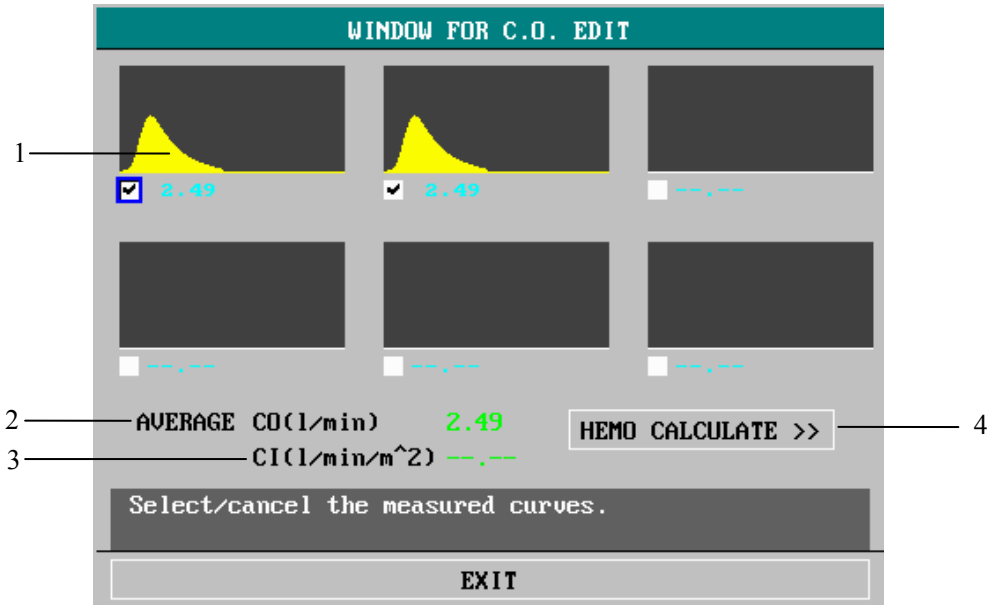


Figure 16-4 Window for CO Editing

1. The curve for one of the six measurements and the corresponding CO value.
2. The average CO value.
3. The average CI value.
4. The function option in the window for CO editing.

Values of selected measurements can be averaged and stored in the CO field in the HEMOD menu for Hemodynamic calculations.

When you access the editing window for the first time, all the curves and the CO values of valid measurements are highlighted, indicating these values are to be averaged. You can rotate the control knob and select the unqualified curve, and then press the control knob to exclude the this measurement from the calculation. The excluded curve becomes white.

NOTE

- **The excluded curve can be selected and counted in the calculation again.**

16.2.2 Blood Temperature Monitoring

- Blood temperature monitoring can function when C.O. measurement is not taken. The blood temperature is measured by the thermistor situated in the distal end of the catheter in the pulmonary artery (see Figure 16-5).
- The blood temperature alarm is disabled during the blood temperature measurement. When the measurement ends, the alarm is enabled automatically.
- The currently measured blood pressure is displayed in the CO parameter window.

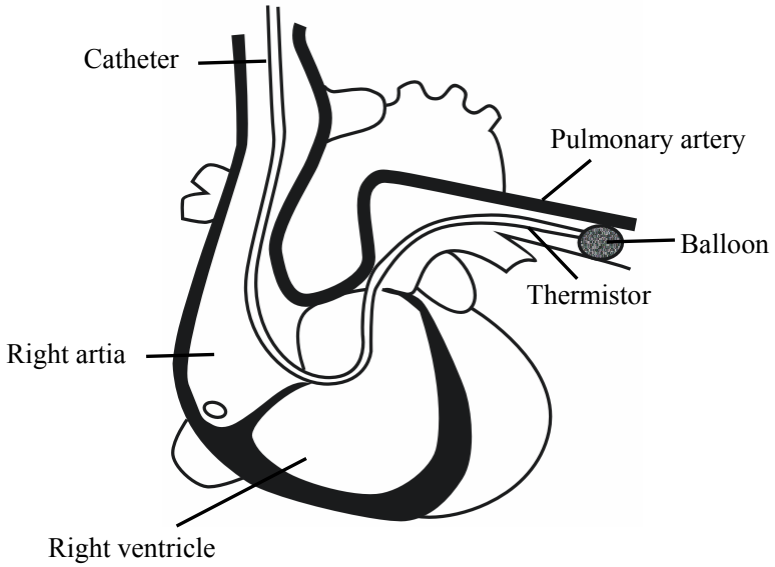


Figure 16-5 Catheter Site

16.3 CO Setup Menu

Select the CO label in the CO parameter window, and the C.O. SELECT menu pops up. You can select the C.O. SETUP option to enter the following menu.

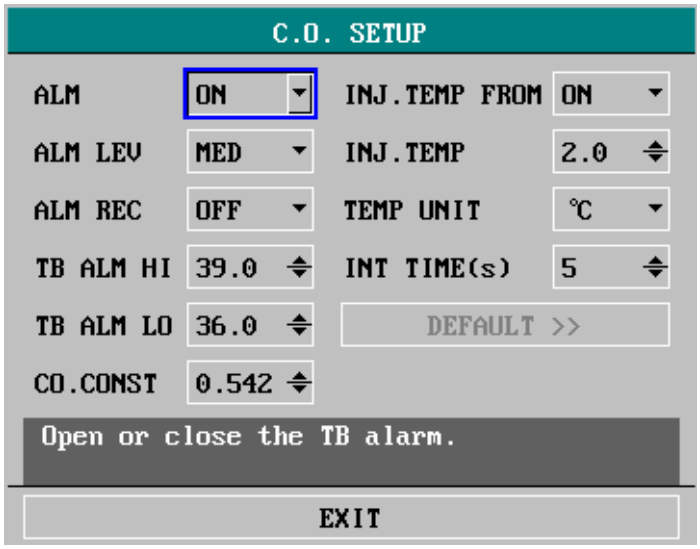


Figure 16-6 C.O. Setup Menu

You can perform the following settings in this menu.

- ALM TB alarm on/off status
  ON: When a TB alarm occurs, the monitor gives alarm indications and stores the alarm;
  OFF: When a TB alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
  When OFF is selected, the icon is displayed on the right of the TB label.

⚠WARNING

- **The blood temperature alarm is disabled during CO measurement.**

- ALM LEV Alarm level
  Options: HIGH, MED and LOW.

- ALM REC — Alarm recording
  ON: When a TB alarm occurs, the monitor enables the recording;
  OFF: When a TB alarm occurs, the monitor does not enable the recording.
- TB ALM HI — TB upper alarm limit
- TB ALM LO — TB lower alarm limit

TB alarm limits:

Parameter	Maxi. Upper	Mini. Lower	Step
TB	43	23	0.1

- CO.CONST — This coefficient is related to the catheter and the injectate volume. After replacing the catheter, you should adjust this coefficient according to the instructions for use.
- INJ. TEMP FROM — Injectate temperature source
  ON: When this option is selected, the system obtains the real-time injectate temperature by placing a sensor in the way of the injectate.
  OFF: When this option is selected, the injectate temperature is given and you can set INJ. TEMP in the menu. The system obtains the preset injectate temperature directly from the setting, instead of real-time detection.
- INJ. TEMP — Injectate temperature
  When the INJ. TEMP FROM option is set to OFF, you can adjust this option to set the injectate temperature.
  Range : 0 to 27℃.
- TEMP UNIT — Temperature unit
  Options: ℃ and ℉.
- INT TIME(s) — The minimum interval between two consecutive measurements
  Unit: second.
  Range: 5 to 300s.
  The time increases or decreases by 5 seconds if you rotate the control knob for one time.
- DEFAULT >> — You can select this option to access the CO DEFAULT CONFIG menu, in which you may select FACTORY DEFAULT CONFIG or USER DEFAULT CONFIG. After finishing your selection and exiting the menu, the system pops up a dialog box asking for your confirmation.

16.4 Hemodynamic Calculation

Select the HEMO CALCULATE >> option from WINDOW FOR C.O. EDIT, the HEMO WINDOW is opened. This window displays the input parameter values and the calculation result.

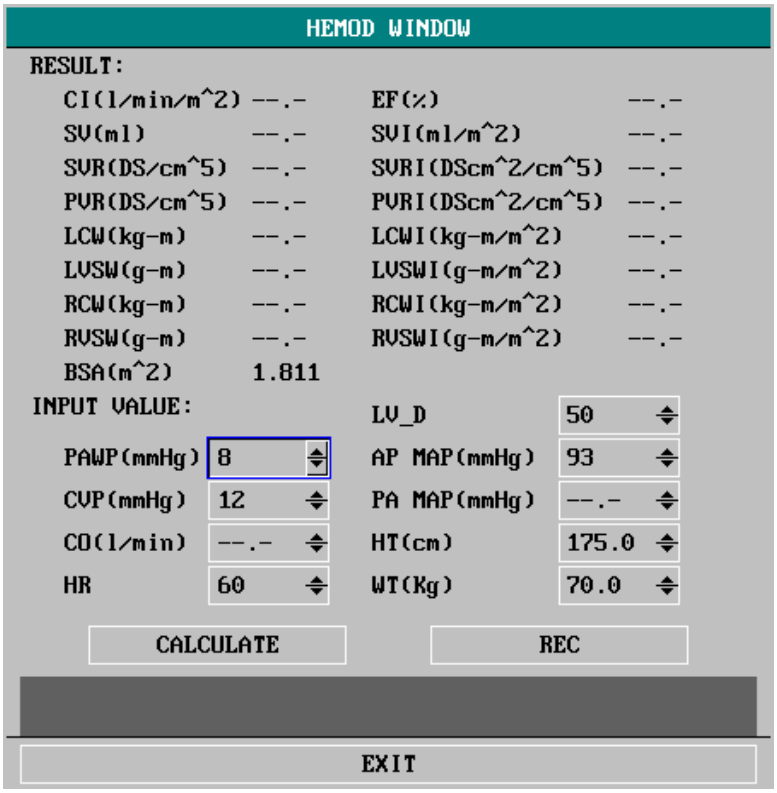


Figure 16-7 Hemodynamic Calculation Window

In the window above, you can rotate the control knob and highlight a parameter field to adjust the value of the selected parameter. After finishing all parameter settings, select the CALCULATE option. The calculation result is displayed in the window immediately. You can also select the REC option to print the calculation result from the recorder.

Input parameters:

- PAWP: Pulmonary Artery Wedge Pressure
- CVP: Central Venous Pressure
- CO: Cardiac Output
- HR: Heart Rate
- AP MAP: Mean Artery Pressure
- LV_D: Left Ventricular Diameter
- PA MAP: Mean Pulmonary Artery Pressure

- HT: Height
- WT: Weight

Hemodynamic calculation result:

Abbreviation	**Full name**	**Calculation formula**
CI	Cardiac index	CO / BSA
BSA	Body surface area	0.0061×HT+0.0128×WT–0.1529
SV	Stroke volume	CO / hr × 1000
SVI	Stroke volume index	SV / BSA
SVR	Systemic vascular resistance	79.96 × (apmap – cvp) / CO
SVRI	Systemic vascular resistance index	SVR × BSA
PVR	Pulmonary vascular resistance	79.96 × (pamap – pawp) / CO
PVRI	Pulmonary vascular resistance index	PVR × BSA
LCW	Left cardiac work	0.0136 × apmap ×CO
LCWI	Left cardiac work index	LCW / BSA
RCW	Right cardiac work	0.0136 × pamap × CO
RCWI	Right cardiac work index	RCW / BSA
LVSW	Left ventricular stroke work	0.0136 × apmap ×SV
LVSWI	Left ventricular stroke work index	LVSW / BSA
RVSW	Right ventricular stroke work	0.0136 × pamap ×SV
RVSWI	Right ventricular stroke work index	RVSW / BSA
EF	Ejection Fraction	SV / fdata × 10
	FDATA	$(7.0/(2.4 + lv\_d / 10)) \times (lv\_d /10)^3$

16.5 Maintenance and Cleaning

⚠WARNING

- **Before cleaning the transducer, make sure it is disconnected from the monitor, or the monitor is powered off and disconnected from the AC power.**

CO Cable Cleaning

- If the adhesive tape residue must be removed from the transducer cable, double seal tape remover can be used because it is very effective. Careful use minimizes the damage to the cable. Acetone, Alcohol, Ammonia, Chloroform, or other strong solvents are not recommended because they are harmful to the vinyl cabling.
- Wet a sponge with the solution of warm water and soap, or other cleaning solution. Use the sponge to clean the cable and then dry it. Do not immerse the cable in water.
- Check each cable for corrosion, cracks and deterioration.

Gas Disinfection

Gas disinfection ensures complete sterilization.

- Remove obvious contamination using the cleaning procedure described above. To inhibit the formation of ethylene glycol when ethylene oxide gas is used as the disinfectant, the transducer should be completely dry.
- Follow the instructions for use provided by the manufacturer of the gas disinfectant.

⚠WARNING

- **Do not autoclave the cable or heat it above 75℃ (167℉). The cable should be stored in an environmental temperature between -20℃ and 75 ℃ (-68℉ to 167℉). It should be hung up or laid flat to prevent damage to the cable.**

FOR YOUR NOTES

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17.1 Overview

The monitor is able to measure the CO_2 pressure of the patient airway, and displays the CO_2 waveform in the waveforms area of the monitor screen. The CO_2 parameter window shows the following parameters:

- End-tidal CO_2 concentration ($EtCO_2$)
- Inspired Minimum CO_2 ($InsCO_2$)
- Air Way Respiration Rate (AwRR)

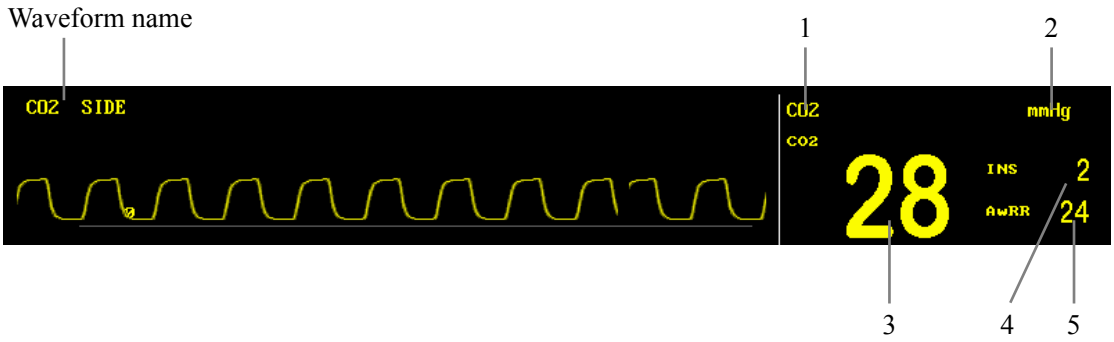


Figure 17-1 CO_2 Waveform and Parameters

1. CO_2 label: This option allows you to access the CO2 SETUP menu.
2. Pressure unit: mmHg or kPa.
3. $EtCO_2$: The measured value of $EtCO_2$.
4. $InsCO_2$: The measured value of $InsCO_2$.
5. AwRR: The measured value of AwRR.

The monitor can be equipped with either Mindray CO_2 module, Oridion CO_2 module, or Welch Allyn CO_2 module. Introduction to these modules are given in the following pages. You can read the pages corresponding to your monitor configuration, and operate your monitor accordingly.

NOTE

- **CO2 and CO_2 are used interchangeably in this chapter.**

17.2 Mindray CO_2 Module

NOTE

- **This section is only applicable to a monitor equipped with a Mindray CO_2 module.**

17.2.1 Principles of Operation

⚠WARNING

- **The CO_2 module should be protected against crash and vibration.**
- **Our CO_2 module is only applicable to pediatric and adult patients, but not to neonate patients.**
- **Inaccurate measurement may occur when the monitor is operating in an environment of excessively high CO_2 content (>0.5%).**

The monitor adopts our sidestream CO_2 module. The measurement of this module is based on the feature that the CO_2 molecule absorbs infrared ray. The measurement procedure is as follows : send the CO_2 to a measurement chamber inside the module through the airway system, and then irradiate 4.26um infrared ray at one side of the chamber and use the sensor to measure the attenuation degree of the received infrared ray at the other side. Since the attenuation degree of the infrared ray is proportional to the concentration of CO_2, the CO_2 concentration is calculated. The measured CO_2 concentration is thereafter converted into the partial pressure under the same temperature and pressure, and then displayed.

The relation between the partial pressure and the CO_2 concentration is given below:

CO_2 partial pressure (mmHg)=

CO_2 concentration (%)×Pamp (ambient pressure, mmHg)/100

CO_2 partial pressure (kPa)= CO_2 partial pressure (mmHg)/7.5

17.2.2 Preparations for CO_2 Measurement

1. Plug the water trap into its receptacle before the measurement.
2. Open the CO2 SETUP menu and set WORK MODE to MEASURE. The "CO2 START UP" prompt information is displayed on the screen until the startup is finished.
3. After the module start-up, the "CO2 WARM UP" prompt information is displayed on the screen. At this time, the module is in the Warming–up status.
4. After the module warm-up, the module enters the Ready-to-measure status.

When the monitor is powered on for the first time, the CO_2 module enters the STANDBY mode by default. To activate the CO_2 module, you must change the work mode to MEASURE. The work mode of the CO_2 module keeps unchanged when the monitor is restarted. For instance, if the monitor is power off when the CO_2 module is working in the MEASURE mode, the CO_2 module will automatically enter the MEASURE mode after the monitor is restarted. For details about WORK MODE, please refer to the section ***Other Setup*** in ***17.2.3 CO2*** .



Figure 17-2 CO_2 Module Airway Connections

The measure CO_2 concentration can be displayed in two units:

- ATPD (Ambient Temperature and Pressure, Dry Gas);
- BTPS (Body temperature and pressure, Saturated);

ATPD means the CO_2 value is measured in ambient temperature and pressure and dry gas, while BTPS means the CO_2 is measured at a temperature of 37℃, a relative humidity of 95% and a 47mmHg (pH2O) partial pressure of moisture.

The calculation formulas in the above two units are as follows:
ATPD: PCO_2 (mmHg)= CO_2 (vol%)× Pamp/100
BTPS: PCO_2 (mmHg)= CO_2 (vol%)×(Pamp-47)/100

In the above formulas, PCO_2 refers to the CO_2 partial pressure, vol% is the percentage of the gas concentration, and Pamp is the ambient pressure in the unit of mmHg.

⚠WARNING

- **Do not use the accessory if the packaging or the internal accessory is damaged. Return it to the manufacturer.**
- **"CO2 START UP" and "CO2 WARM UP" displayed on the screen indicate that the sensor is starting up and warming up. During the warming up, the module can measure CO_2, but the measurement is not standard. After the above information disappears, the standard measurement can be performed.**
- **The sidestream sampling line is disposable. It should not be disinfected for reuse or cross-used by different patients.**
- **The water trap is used to collect water drops condensed in the sampling airway and prevent water drops from entering the module. When the collected water reaches to a certain amount, remove the water to avoid blocking the airway.**
- **In the long-term use, dust or other substances may lower the air permeability of the filter material in the water trap and may block the airway. In this situation, the water trap must be replaced.**

17.2.3 CO_2 Setup Menu

Selecting the CO_2 label in the parameter window opens the following menu.

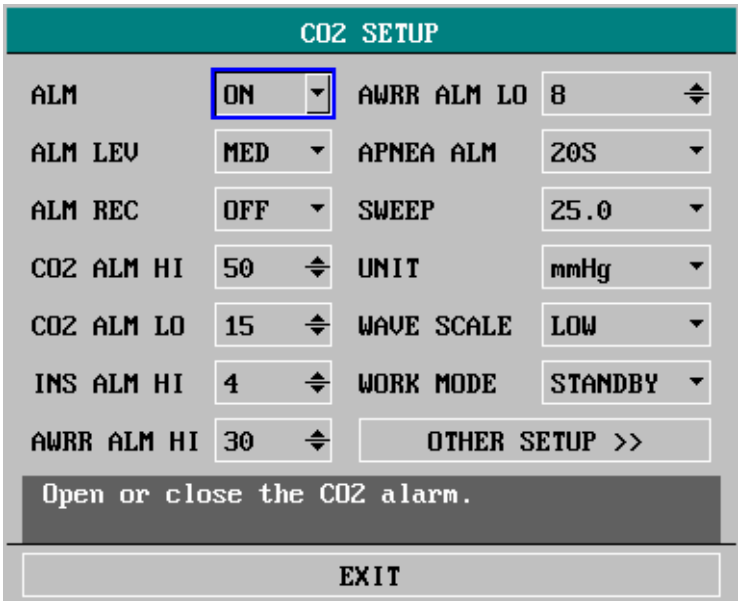


Figure 17-3 CO_2 Setup Menu

You can perform the following settings in this menu.

- ALM — Alarm on/off status
  ON: When a CO_2 alarm occurs, the monitor gives alarm indications and stores the alarm;
  OFF: When a CO_2 alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
  When OFF is selected, the icon is displayed on the right of the CO_2 label.
- ALM LEV — Alarm level
  Options: HIGH, MED and LOW.
- ALM REC — Alarm recording
  ON: When a CO_2 alarm occurs, the monitor enables the recording;
  OFF: When a CO_2 alarm occurs, the monitor does not enable the recording.
- CO2 ALM HI — Upper alarm limit of $EtCO_2$
- CO2 ALM LO — Lower alarm limit of $EtCO_2$
- INS ALM HI — Upper alarm limit of $InsCO_2$

- AWRR ALM HI — Upper alarm limit of AwRR
- AWRR ALM LO — Lower alarm limit of AwRR
- APNEA ALM — Determines the apnea alarm delay.
  If the apnea of the patient exceeds the preset apnea alarm delay, the monitor triggers an alarm and gives the " CO2 APNEA " alarm message.
  Options: 10S, 15S, 20S, 25S, 30S, 35S and 40S.
- SWEEP — Waveform speed
  Options: 6.25, 12.5 and 25.0.
  Unit: mm/s.
- UNIT — Options: mmHg, kPa and %.
- WAVE SCALE — Options: HIGH and LOW.
  This option allows you to adjust the amplitude of the CO_2 waveform.
- WORK MODE — Options: MEASURE and STANDBY.
  To start the CO_2 monitoring, select the MEASURE mode. In the STANDBY mode, the air pump and infrared ray source of the CO_2 module are disabled. Hence, decreases the power consumption and prolongs the operating life of infrared ray source and the whole CO_2 module.

NOTE

- **The apnea alarm cannot be disabled.**
- **When the CO_2 monitoring is not required, it is recommended the water trap not be connected and the work mode be set to STANDBY.**

Other Setup

Selecting OTHER SETUP option opens the following menu.

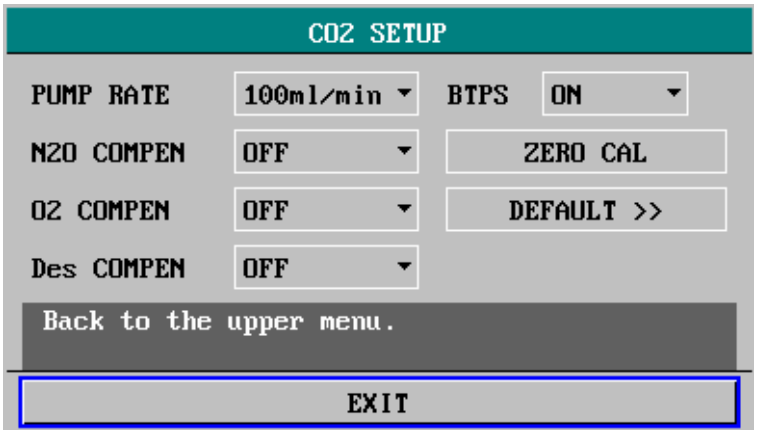


Figure 17-4 CO_2 Other Setup Menu

You can perform the following settings in this menu.

- PUMP RATE — Determines the sampling rate of the CO_2 module pump.
  Options: 150ml/min, 100ml/min
- N2O COMPEN — N_2O compensation
  ON: Select ON, when the N_2O content in the measured gas is no smaller than 30%.
  OFF: Select OFF, when the N_2O content in the measured gas is smaller than 30%.
- O2 COMPEN — O_2 compensation
  ON: Select ON, when the O_2 content in the measured gas is no smaller than 50%.
  OFF: Select OFF, when the O_2 content in the measured gas is smaller than 50%.
- Des COMPEN — Desflurane compensation
  ON: Select ON, when the desflurane is contained in the measured gas.
  OFF: Select OFF, when the deflurane is not contained in the measured gas.
- BTPS — Body Temperature and Pressure, Saturated
  Options: ON and OFF.

NOTE

- **Set the N_2O COMPEN, O_2 COMPEN and Des COMPEN according to the practical situation. Incorrect setting might incur errors from the actual value and cause misdiagnosis.**

When BTPS is turned ON, the system performs BTPS compensation automatically; when BTPS is turned OFF, the BTPS compensation is disabled.

When measuring the CO_2 content inside the patient's lung, turn ON BTPS. Normally, the lung temperature of the patient is 37℃ and the water vapor is sufficient or regarded as saturated. But the temperature and water vapor content of the sampling line are different from the patient's exhalation. Thus, when the patient's exhalation passes the sampling line, the accuracy of the CO_2 concentration measured by the sensor will be adversely affected. To ensure an accurate measurement, you should turn ON the BTPS. In this mode, the system adjusts the calculation coefficient automatically, so that the measured value is just the actual CO_2 content in the patient's lung.

When measuring the CO_2 content of the environment or a certain vessel, turn OFF BTPS. In the standard ambient pressure and dry gas, the accuracy of the sensor measurement is not affected.

NOTE

- **When measuring a moist gas of saturated water vapor at the body temperature and the ambient pressure, turn ON BTPS; when measuring a dry gas at the ambient temperature and pressure, turn OFF BTPS.**

- ZERO CAL — This option allows you to zero manually so as to eliminate the adverse affect of baseline drift in the process of measurement.
- DEFAULT >> — Select DEFAULT >> to access the CO2 DEFAULT CONFIG menu. You can select either FACTORY DEFAULT CONF or USER DEFAULT CONF. After finishing the selection and exiting the menu, a dialog pops up asking for confirmation of your selection.

17.2.4 CO_2 User Maintain Menu

Select CO2 USER MAINTAIN >> in USER MAINTAIN menu. The following menu appears.



Figure 17-5 CO_2 User Maintain Menu

The following information is displayed in the menu above.

- CO2 — The currently measured CO_2 content.
  Unit: %.

In the field at the right of the CO_2 value, you can select a standard gas containing a certain amount of CO_2 for calibration.
Options: 3%, 4%, 5%, 6% and 7%.

- BAROMETRIC — The currently measured barometric pressure.
  Unit: mmHg.
- SENSOR TEMP — The currently measured temperature around the infrared sensor.
  Unit: ℃.
- CUR PUMP RATE — The currently measured pumping rate.
  Unit: ml/min.
- SET PUMP RATE — Selectable pumping rate
  Options: HIGH and LOW.

- ZERO CAL — This option allows you to zero the CO_2 module, so as to eliminate the adverse affect of the baseline drift in the process of measurement. Perform zeroing prior to concentration calibration.
- CONFIRM CAL — This option allows you to confirm the calibration of the CO_2 module.

Calibration Procedure

1. Verify the module enters the ready-to-measure status.
2. Connect a gas bottle with the CO_2 sensor connector on the monitor as shown below.

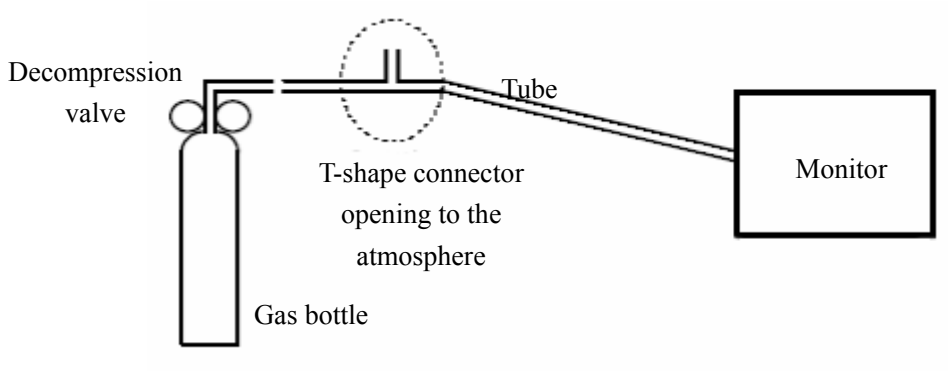


Figure 17-6 Connections for Calibration

3. Fill the gas bottle with a standard gas of certain CO_2 content (3%, 4%, 5%, 6% and 7%), and input the gas to the monitor.
4. Open the CO2 USER MAINTAIN menu, and set the CO_2 field to a value, which is the same with the CO_2 content of the gas bottle.
5. When the CO2 USER MAINTAIN menu displays the currently measured CO_2 content, wait until a stable reading is indicated, and then select the CONFIRM CAL option to start calibrating the CO_2 module.
6. If the calibration succeeds, “CALIBRATE SUCCESS!” will be displayed in the CO2 USER MAINTAIN menu. If fails, “CAL FAIL, TRY AGAIN!” will be displayed, and re-calibration is required.
7. Select the EXIT option to exit the CO2 USER MAINTAIN menu.

17.2.5 Maintenance and Cleaning

- The sampling line of the sidestream CO_2 module is disposable and cannot be disinfected for reuse.
- In case of an exception in the sampling system of the CO_2 module, check for entanglement of the sampling line. If the sampling line is not entangled, remove it from the water trap. In this situation, if the screen displays a prompt information indicating the CO_2 sampling line is abnormal, the water trap must have been blocked, and you must replace it with a new one. If no prompt information is given, the sampling line must have been blocked, and you should replace with a new sampling line.
- Routine calibration of the sidestream CO_2 module is not required. But the calibration must be performed every year, or when great inaccuracy of measurement is found.

17.3 Oridion CO_2 Module

NOTE

- **This section is applicable to a monitor equipped with the Oridion CO_2 module only.**

17.3.1 Principles of Operation

⚠WARNING

- **The CO_2 module should be protected against crash and vibration.**
- **The Oridion CO_2 module is applicable to neonate, pediatric as well as adult patients.**
- **Inaccurate measurement may occur when the monitor is operating in an environment of excessively high CO_2 content (>0.5%).**

The monitor adopts the sidestream Oridion CO_2 module. The measurement of this module is based on the feature that the CO_2 molecule absorbs infrared ray. The measurement procedure is as follows : send the CO_2 to a measurement chamber inside the module through the airway system, and then irradiate 4.26um infrared ray at one side of the chamber and use the sensor to measure the attenuation degree of the received infrared ray at the other side. Since the attenuation degree of the infrared ray is proportional to the concentration of CO_2, the CO_2 concentration is calculated. The measured CO_2 concentration is thereafter converted into the partial pressure under the same temperature and pressure, and then displayed.

The relation between the partial pressure and the CO_2 concentration is given below:

CO_2 partial pressure (mmHg)=

CO_2 concentration (%)×Pamp (ambient pressure, mmHg)/100

CO_2 partial pressure (kPa)= CO_2 partial pressure (mmHg)/7.5

17.3.2 Preparations for CO_2 Measurement

1. Plug the sampling line into its receptacle before the measurement.
2. Open the CO2 SETUP menu and set WORK MODE to MEASURE.
3. The “CO2 START UP” prompt information is displayed on the screen until the startup is finished.

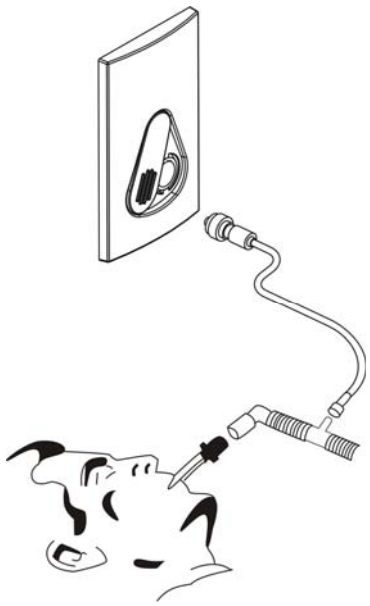


Figure 17-7 CO_2 Module Airway Connections

When the monitor is powered on for the first time, the CO_2 module enters the STANDBY mode by default. To activat the CO_2 module, you must change the work mode to MEASURE. The work mode of the CO_2 module keeps unchanged when the monitor is restarted. For instance, if the monitor is power off when the CO_2 module is working in the MEASURE mode, the CO_2 module will automatically enter the MEASURE mode after the monitor is restarted. For details about WORK MODE, please refer to the section ***17.3.3 CO2*** .

⚠WARNING

- **Do not use the accessory if the packaging or the internal accessory is damaged. Return it to the manufacturer.**
- **The sidestream sampling line is disposable. It should not be disinfected for reuse or cross-used by different patients.**

17.3.3 CO_2 Setup Menu

Selecting the CO_2 label in the parameter window opens the following menu.

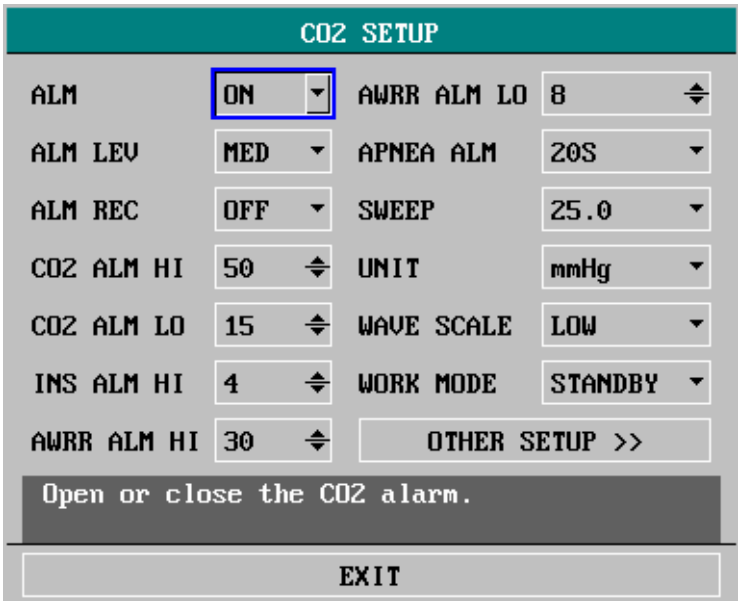


Figure 17-8 CO_2 Setup Menu

You can perform the following settings in this menu.

- ALM — Alarm on/off status
  ON: When a CO_2 alarm occurs, the monitor gives alarm indications and stores the alarm;
  OFF: When a CO_2 alarm occurs, the monitor neither gives alarm indications nor stores the alarm;
  When OFF is selected, the icon is displayed on the right of the CO_2 label.
- ALM LEV — Alarm level
  Options: HIGH, MED and LOW.
- ALM REC — Alarm recording
  ON: When a CO_2 alarm occurs, the monitor enables the recording;
  OFF: When a CO_2 alarm occurs, the monitor does not enable the recording.
- CO2 ALM HI — Upper alarm limit of $EtCO_2$
- CO2 ALM LO — Lower alarm limit of $EtCO_2$
- INS ALM HI — Upper alarm limit of $InsCO_2$

- AWRR ALM HI — Upper alarm limit of AwRR
- AWRR ALM LO — Lower alarm limit of AwRR
- APNEA ALM — Determines the apnea alarm delay.
  If the apnea of the patient exceeds the preset apnea alarm delay, the monitor triggers an alarm and gives the "CO2 APNEA" alarm message.
  Options: 10S, 15S, 20S, 25S, 30S, 35S and 40S.
- SWEEP — Waveform speed
  Options: 6.25, 12.5 and 25.0.
  Unit: mm/s.
- UNIT — Options: mmHg, kPa And %.
- WAVE SCALE — Options: HIGH and LOW.
  This option allows you to adjust the amplitude of the CO_2 waveform.
- WORK MODE — Options: MEASURE and STANDBY.
  To start the CO_2 monitoring, select the MEASURE mode. In the STANDBY mode, the air pump and infrared ray source of the CO_2 module are disabled. Hence, decreases the power consumption and prolongs the operating life of infrared ray source and the whole CO_2 module.

NOTE

- **When the CO_2 monitoring is not required, it is recommended the work mode be set to STANDBY.**

Other Setup

Selecting the OTHER SETUP option opens the following menu.

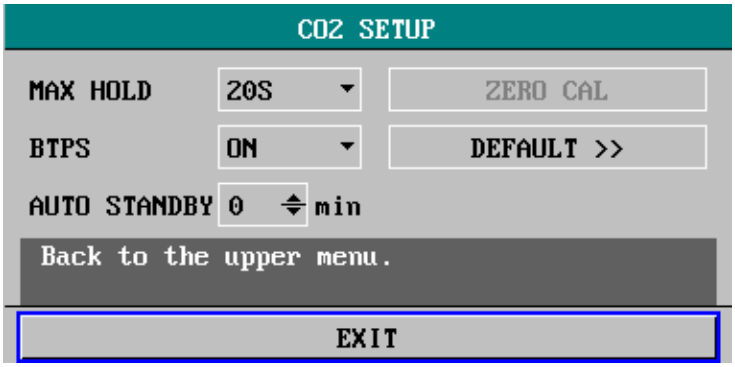


Figure 17-9 CO_2 Other Setup Menu

You can perform the following settings in this menu.

- MAX HOLD — Maximum holding time
  It determines the maximum holding time of the CO_2 parameters.
  Options: OFF, 10S, 20S and 30S.
- BTPS — Body temperature and pressure, Saturated
  Options: ON and OFF.

When BTPS is turned ON, the system performs BTPS compensation automatically; when BTPS is turned OFF, the BTPS compensation is disabled.

When measuring the CO_2 content inside the patient's lung, turn ON BTPS. Normally, the lung temperature of the patient is 37℃ and the water vapor is sufficient or regarded as saturated. But the temperature and water vapor content of the sampling line are different from the patient's exhalation. Thus, when the patient's exhalation passes the sampling line, the accuracy of the CO_2 concentration measured by the sensor will be adversely affected. To ensure an accurate measurement, you should turn ON the BTPS. In this mode, the system adjusts the calculation coefficient automatically, so that the measured value is just the actual CO_2 content in the patient's lung.

When measuring the CO_2 content of the environment or a certain vessel, turn OFF BTPS. In the standard ambient pressure and dry gas, the accuracy of the sensor measurement is not affected.

NOTE

- **When measuring a moist gas of saturated water vapor at the body temperature and the ambient pressure, turn ON BTPS; when measuring a dry gas at the ambient temperature and pressure, turn OFF BTPS.**

- AUTO STANDBY — Range: 0 to 60min. If no respiration waveform is detected in the selected time, the CO_2 module enters the standby mode automatically. When AUTO STANDBY is set to 0min, it means the CO_2 module is in MEASURE state. If the sampling line is not connected, the CO_2 module enters the standby mode automatically 3 minutes later.
- ZERO CAL — This option allows you to zero manually so as to eliminate the adverse affect of baseline drift in the process of measurement.
- DEFAULT >> — Select DEFAULT >> to access the CO2 DEFAULT CONFIG menu. You can select either FACTORY DEFAULT CONF or USER DEFAULT CONF. After finishing the selection and exiting the menu, a dialog pops up asking for confirmation of your selection.

17.3.4 CO_2 User Maintain Menu

Select CO2 USER MAINTAIN >> in USER MAINTAIN menu. The following menu appears.

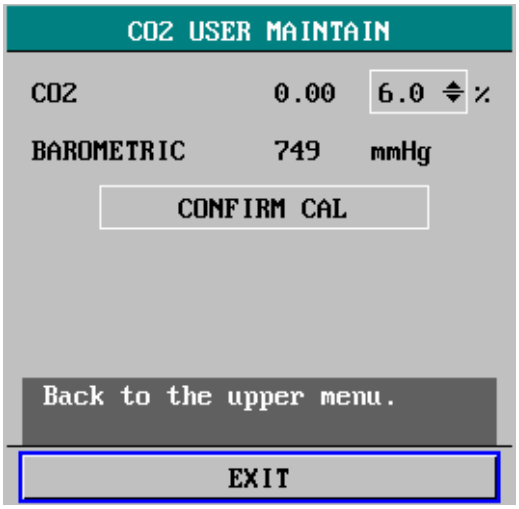


Figure 17-10 CO_2 User Maintain Menu

The following information is displayed in the menu above.

- CO2 The currently measured CO_2 content.
  Unit: %.

In the field at the right of the CO_2 value, you can select a standard gas containing a certain amount of CO_2 for calibration.

- BAROMETRIC The currently measured barometric pressure.
  Unit: mmHg.
- CONFIRM CAL This option allows you to confirm the calibration of the CO_2 module.

Calibration Procedure

1. Verify the module enters the Full Accuracy Mode.
2. Connect a gas bottle with the CO_2 sensor connector on the monitor as shown below.

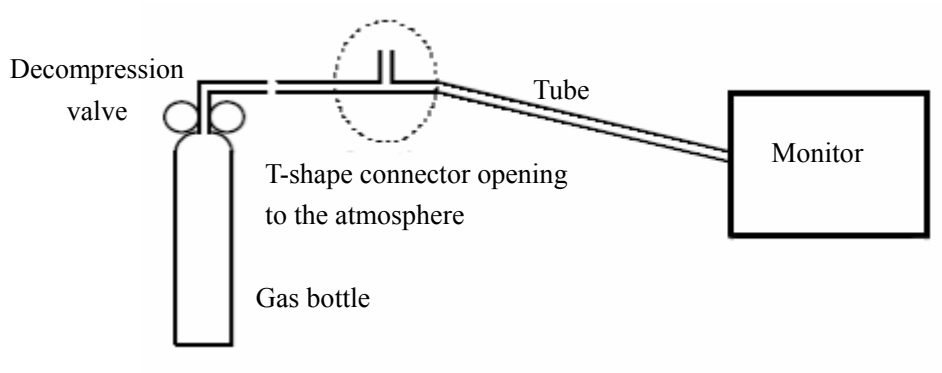


Figure 17-11 Connections for Calibration

3. Fill the gas bottle with a standard gas of certain CO_2 content (4% to 6%), and input the gas to the monitor.
4. Open the CO2 USER MAINTAIN menu, and set the CO_2 field to a value, which is the same with the CO_2 content of the gas bottle.
5. When the CO2 USER MAINTAIN menu displays the currently measured CO_2 content, wait until a stable reading is indicated, and then select the CONFIRM CAL option to start calibrating the CO_2 module.
6. If the calibration succeeds, “CALIBRATE SUCCESS!” will be displayed in the CO2 USER MAINTAIN menu. If fails, “CAL FAIL, TRY AGAIN!” will be displayed, and re-calibration is required.
7. Select the EXIT option to exit the CO2 USER MAINTAIN menu.

17.3.5 Maintenance and Cleaning

- The sampling line of the micorstream CO_2 module is disposable and cannot be disinfected for reuse.
- Routine calibration of the microstream CO_2 module is not required. But the calibration must be performed if it is prompted in the CO2 USER MATINTAIN menu, or great inaccuracy of measurement is found.

17.3.6 Oridion Information

Microstream

This trademark is registered in Isreal, Japan, Germany and US.

Oridion Patents

This device and the CO_2 sampling consumable designed for use herewith is covered by one or more of the following USA patents: 4,755,675; 5,300,859; 5,657,750; 5,857,461 and international equivalents. USA and international patents pending.

No Implied Licence

Possession or purchase of this device does not convey any express or implied license to use the device with unauthorized consumable CO_2 sampling consumable products which would, alone, or in combination with this device, fall within the scope of one or more of the patents relating to this device and/or CO_2 sampling consumable products.

17.4 Welch Allyn CO_2 Module

NOTE

- **This section is applicable to a monitor equipped with a Welch Allyn CO_2 module only.**

17.4.1 Principles of Operation

⚠WARNING

- **The CO_2 module should be protected against crash and vibration.**
- **The Welch Allyn CO_2 module is applicable to neonate, pediatric as well as adult patients.**

The monitor adopts the mainstream Welch Allyn CO_2 module. The measurement of this module is based on the feature that the CO_2 molecule absorbs 4.3um infrared ray. The measurement procedure is as follows : send the CO_2 to a measurement chamber inside the module through the airway system, and then irradiate infrared ray at one side of the chamber and use the sensor to measure the attenuation degree of the received infrared ray at the other side. Since the attenuation degree of the infrared ray is proportional to the concentration of CO_2, the CO_2 concentration is calculated.

The relation between the partial pressure and the CO_2 concentration is given below:
CO_2 partial pressure (mmHg)=

CO_2 concentration (%)×Pamp (ambient pressure, mmHg)/100

This module adopts the Autorun measurement. The rate of the waveform sampling is once per 31 milliseconds. The operation sequence is as follows: when the monitor is powered on, the CO_2 module starts warming up automatically for 45s－90s. Then the sensor motor is activated. Around 5s－10s later, the infrared ray source is turned on, and about 10s later the module enters normal measurement mode.

17.4.2 Preparations for CO_2 Measurement

1. Plug the water trap into its receptacle before the measurement.
2. Power on the monitor and open the CO2 SETUP menu. In the menu, set the WORK MODE to MEASURE.
3. The "CO2 WARM UP" technical information is displayed on the screen until the sensor reaches its work temperature.

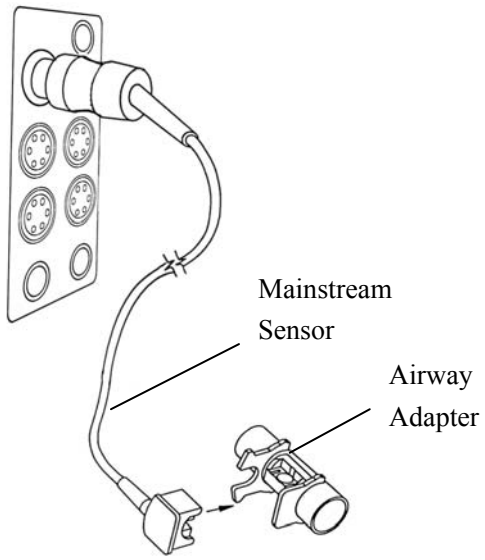


Figure 17-12 CO_2 Module Airway Connections

When the monitor is powered on for the first time, the CO_2 module enters the STANDBY mode by default. To activat the CO_2 module, you must change the work mode to MEASURE. The work mode of the CO_2 module keeps unchanged when the monitor is restarted. For instance, if the monitor is power off when the CO_2 module is working in the MEASURE mode, the CO_2 module will automatically enter the MEASURE mode after the monitor is restarted. For details about WORK MODE, please refer to the section ***Other Setup*** of ***17.4.3 CO2 Setup Menu***.

NOTE

- **Do not use the accessory if the packaging or the internal accessory is damaged. Return it to the manufacturer.**
- **"CO2 START UP" and "CO2 WARM UP" displayed on the screen indicate that the sensor is starting up and warming up. During the warming up, the module can measure CO_2, but the measurement is not standard. After the above information disappears, the standard measurement can be performed.**

17.4.3 CO_2 Setup Menu

Selecting the CO_2 label in the parameter window opens the following menu.

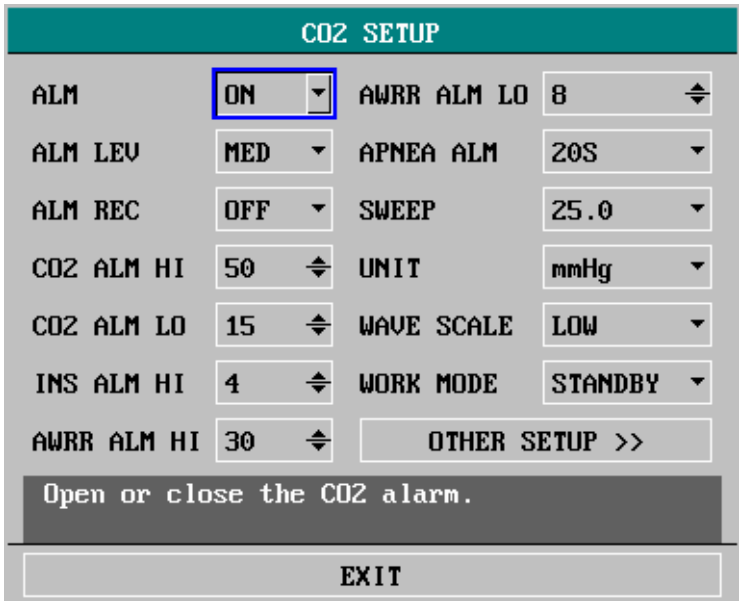


Figure 17-13 CO_2 Setup Menu

You can perform the following settings in this menu.

■ ALM　　Alarm on/off status

ON: When a CO_2 alarm occurs, the monitor gives alarm indications and stores the alarm;

OFF: When a CO_2 alarm occurs, the monitor neither gives alarm indications nor stores the alarm;

When OFF is selected, the icon is displayed on the right of the CO_2 label.

- ALM LEV — Alarm level
  Options: HIGH, MED and LOW.
- ALM REC — Alarm recording
  ON: When a CO_2 alarm occurs, the monitor enables the recording;
  OFF: When a CO_2 alarm occurs, the monitor does not enable the recording
- CO2 ALM HI — Upper alarm limit of $EtCO_2$
- CO2 ALM LO — Lower alarm limit of $EtCO_2$
- INS ALM HI — Upper alarm limit of $InsCO_2$
- AWRR ALM HI — Upper alarm limit of AwRR
- AWRR ALM LO — Lower alarm limit of AwRR
- APNEA ALM — Determines the apnea alarm delay.
  If the apnea of the patient exceeds the preset apnea alarm delay, the monitor triggers an alarm and gives the " CO2 APNEA " alarm message.
  Options: 10S, 15S, 20S, 25S, 30S, 35S and 40S.
- SWEEP — Waveform speed
  Options: 6.25, 12.5 and 25.0.
  Unit: mm/s.
- UNIT — Options: mmHg and kPa.
- WAVE SCALE — Options: HIGH and LOW.
  This option allows you to adjust the amplitude of the CO_2 waveform.
- WORK MODE — Options: MEASURE and STANDBY.
  To start the CO_2 monitoring, select the MEASURE mode.
  In the STANDBY mode, the air pump and infrared ray source of the CO_2 module are disabled. Hence, decreases the power consumption and prolongs the operating life of infrared ray source and the whole CO_2 module.

NOTE

- **The apnea alarm cannot be disabled.**
- **When the CO_2 monitoring is not required, it is recommended the sensor not be connected and the work mode be set to STANDBY.**

Other Setup

Selecting OTHER SETUP opens the following menu.

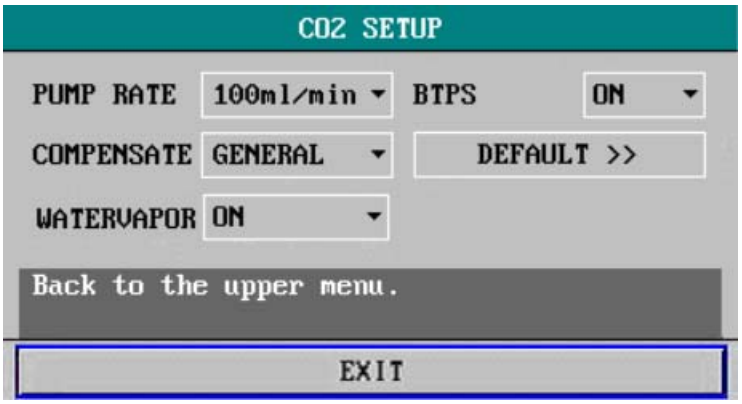


Figure 17-14 CO_2 Setup Menu

You can perform the following settings in this menu.

- PUMP RATE — Determines the sampling rate of the CO_2 module pump.
  Options: 200ml/min, 150ml/min and 100ml/min.
- COMPENSTATE — You can select the gas for compensation.
  Options: GENERAL/O2/N2O/DES/ALL.

Conditions for CO_2 calculation compensation

Compensation type	O_2 correction	N_2O/ DES correction	Conditions
GENERAL	OFF	OFF	$O_2 \leqslant 60\%$, no N_2O
O2	ON	OFF	$O_2 > 50\%$, no N_2O
DES	OFF	ON	$O_2 \leqslant 60\%$, N_2O contained or DES $\geqslant 12\%$
ALL	ON	ON	$O_2 > 60\%$, N_2O contained

Operation method: select a compensation type (GENERAL, O2, DES or ALL) as described above, and then select to turn ON or OFF the water vapor compensation (VA) and BTPS compensation.

- WATERVAPOR — Water vapor compensation
  Options: ON and OFF.

Water vapor compensation is based on the feature that CO_2 absorbs infrared rays. Normally, the patient's exhalation contains some water vapor, which may adversely affect the measurement result. Thus, the water vapor compensation should be turn ON. When measuring dry gas, however, the water vapor compensation should be turned OFF. For example, the water vapor compensation is not necessary when measuring the CO_2 content inside an incubator.

- BTPS — Body Temperature and Pressure, Saturated
  Options: ON and OFF.

When BTPS is turned ON, the system performs BTPS compensation automatically; when BTPS is turned OFF, the BTPS compensation is disabled.

When measuring the CO_2 content inside the patient's lung, turn ON BTPS. Normally, the lung temperature of the patient is 37℃ and the water vapor is sufficient or regarded as saturated. But the temperature and water vapor content of the sampling line are different from the patient's exhalation. Thus, when the patient's exhalation passes the sampling line, the accuracy of the CO_2 concentration measured by the sensor will be adversely affected. To ensure an accurate measurement, you should turn ON the BTPS. In this mode, the system adjusts the calculation coefficient automatically, so that the measured value is just the actual CO_2 content in the patient's lung.

When measuring the CO_2 content of the environment or a certain vessel, turn OFF BTPS. In the standard ambient pressure and dry gas, the accuracy of the sensor measurement is not affected.

NOTE

- **Set the compensation type according to the practical situation. Incorrect setting might incur errors from the actual value and cause misdiagnosis.**
- **The water vapor compensation is turn ON by default. Turn OFF water vapor compensation when measuring dry gas, such as when performing regular maintenance or measurement validation using dry calibrated gas.**
- **The BTPS compensation is turn ON by default. When measuring a damp gas at the body temperature and of saturated water vapor, turn ON BTPS; when measuring a dry gas at the ambient temperature and pressure, turn OFF BTPS.**
- **Perform the calculation compensation by strictly following the operating method.**

- DEFAULT >> — Select DEFAULT >> to access the CO2 DEFAULT CONFIG menu. You can select either FACTORY DEFAULT CONF or USER DEFAULT CONF. After finishing the selection and exiting the menu, a dialog pops up asking for confirmation of your selection.

17.4.4 Maintenance and Cleaning

This mainstream CO_2 module adopts a disposable airway connector, which cannot be disinfected for reuse.

Routine calibration of the mainstream CO_2 module is not required.

Removing Exhaust Gases from the System
Anesthetics: When using the CO_2 measurement on patients who are receiving or have recently received anesthetics, connect the outlet to a scavenging system, or to the anesthesia machine/ventilator, to avoid exposing medical staff to anesthetics.

To remove the sample gas to a scavenging system, connect an exhaust tube to the gas outlet connector of the module.

18 Anesthesia Gas Monitoring

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18.1 Overview

The anesthesia gas (AG) monitoring can be used for measuring the anesthesia gas and respiration gas of the patient in the anesthetic status. This monitor can configure AION 02 AG module or AION 03 AG module. AG module provides the end-tidal numerics and inhaling numerics of the gases mentioned below.

- Carbon dioxide (CO_2): The measured numeric is $EtCO_2$ (Max. exhaling value: Max. exhaling numeric detected during the respiration).
- Nitrous oxide (N_2O): Laughing gas.
- Oxygen (O_2): Optional function.
- Anesthetic (AA): Refers to the monitored anesthetic (DES, ISO, ENF, SEV or HAL).
- Airway respiration rate (AwRR): respiration per minute (BrPM).

The patient monitor can display simultaneously a maximum of 4 waveforms, including the CO_2 waveform (default waveform), N_2O waveform, O_2 waveform and the anesthetic (ENF: Enflurane) waveform.

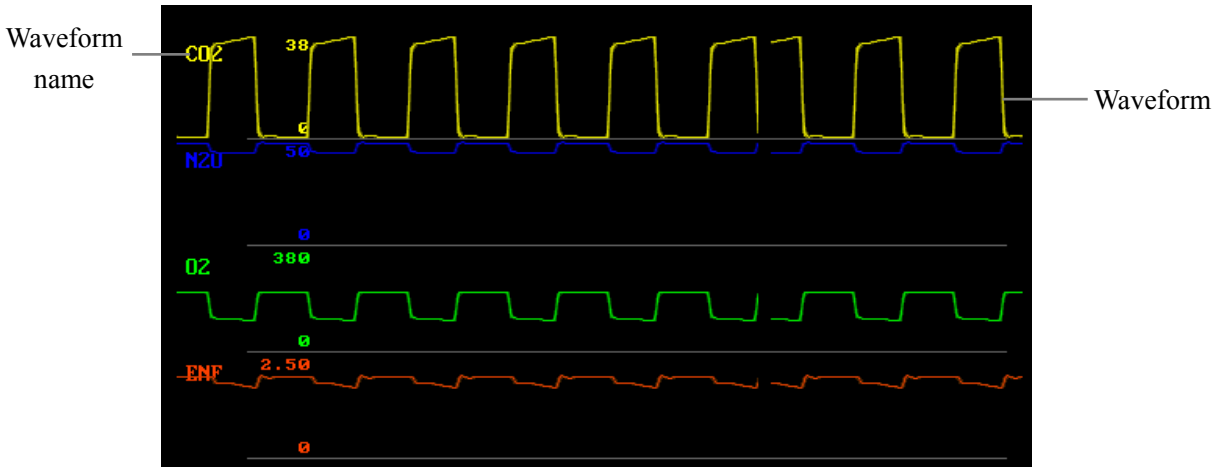


Figure 18-1 AG waveform

In addition, the patient monitor can display parameters, including CO_2, N_2O, O_2 and AA (Which refers to the monitored anesthetic: DES, ISO, ENF, SEV or HAL). It also displays the inhaling and exhaling numerics as well as MAC (Minimum Alveolar Concentration)/MAL (balance gas) and AwRR.

When the O_2 module is not connected, no O_2 waveform will be displayed.
After the O_2 module is connected, whether the O_2 waveform is displayed depends on

whether the O_2 waveform is switched on in the configuration.

Parameters:

- CO_2: Carbon dioxide
- N_2O: Nitrous oxide (lauging gas)
- O_2: Oxygen
- AwRR: Airway respiration rate (respiration per minute, BrPM)
- HAL: Halothame
- ISO: Isoflurane
- ENF: Enflurane
- SEV: Sevoflurane
- DES : Desflurane

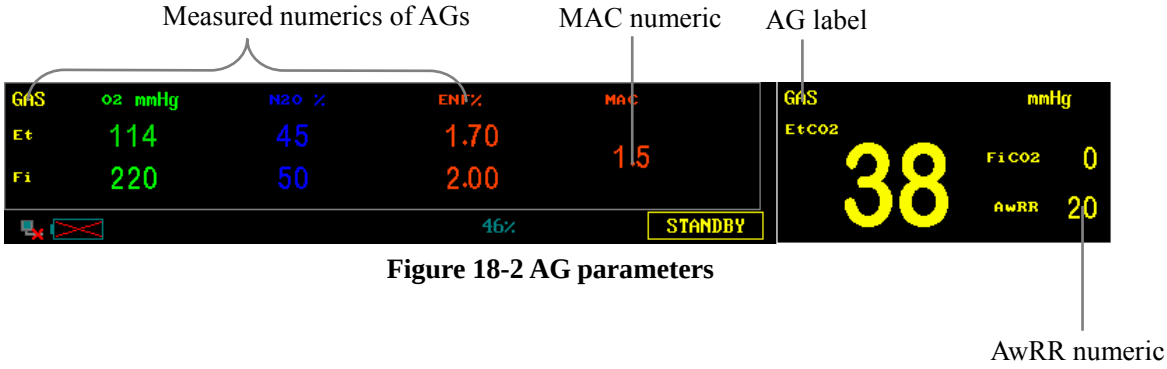


Figure 18-2 AG parameters

NOTE

- **The waveform and value of only one anesthetic can be displayed at one time.**
- **If there are too many waveforms to be displayed, the O_2 waveform will probably not be displayed even though the O_2 module is connected and the O_2 waveform is swithed on in the configuration**

18.2 Measurement Principles and Procedure

Measurement principle of AGs

The AG concentration is measured based on the rationale that the AGs have the property of absorbing the infrared.

The AG module can measure gases that have various properties of absorbing the infrared. To measure the concentration of a gas, send it to the sampling room, select the infrared of a specific wavelength with an optical infrared filter, and transmit it through the gas. For a given volume of gas, the higher its concentration is, the more the infrared that will be absorbed by the gas is, and the less the infrared that will be transmitted through the gas is. The concentration of the measured gas is in inverse proportion to the volume of the infrared that is transmitted through the gas. Therefore, the AG concentration can be obtained by calculating the infrared. For the AG module that implements the measurements of multiple gases, multiple infrared filters are necessary.

Measurement principle of O_2

The oxygen (O_2) does not absorb the infrared within the above-mentioned wavebands, so the oxygen is measured based on its paramagnetism. Inside the sensor of the O_2 module, there are two crystal balls full of nitrogen. They are suspended in the symmetrical magnetic field, and they are designed to point to the strongest outgoing part of the magnetic field. Outside the balls is the paramagnetic oxygen. Therefore, the balls are forced, by the relatively stronger paramagnetic oxygen, out of the magnetic field. The moment of the force acting on the balls is proportional to the paramagnetic strength as well as to the concentration of the oxygen.

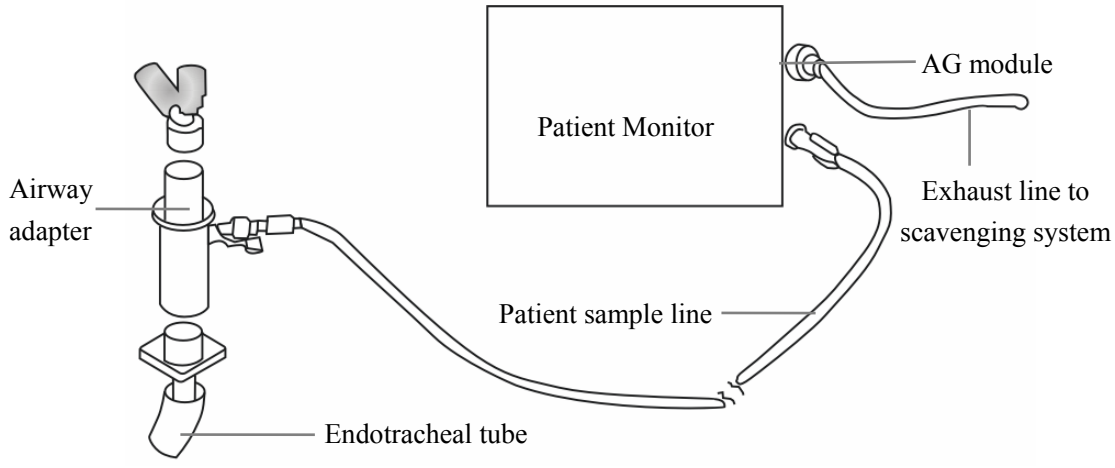


Figure 18-3 Connections for AG measurements

⚠WARNING

- **Ensure the compactness of the connection when performing gas measurements. Any leakage in the system will lead to incorrect readings because this leakage will make the surrounding environmental air mix up with the patient gas.**
- **The water trap is used for collecting water condensates to protect the module from the ingress of water; when the collected water in the water trap reaches a specific volume, it must be removed, thus to avoid clogging in the gas system.**
- **The water trap has filter materials inside, which protect the module from being contaminated by bacterium, liquid, or patient secretion. When the water trap works for a long time, dusts or other foreign bodies may block the filter materials, or even result in system clogging. In this case, replace the water trap. The recommended replacement period is 2 months.**
- **Only gas sampling hoses recommended for the patient monitor are permitted. Otherwise, the performance and reliability of the AG module may be decreased.**
- **In case a gas sampling hose is knotted, disuse it. Because the knot may cause clogging or leakage.**
- **When an inspiratory anesthetic is used, use an exhaust hose to connect the outlet of the AG module to the exhaust disposal system of the hospital or to the anesthetic/respiration machine.**

18.3 AG Setup Menu

Select the GAS label in the parameter window. The AG SETUP menu appears.

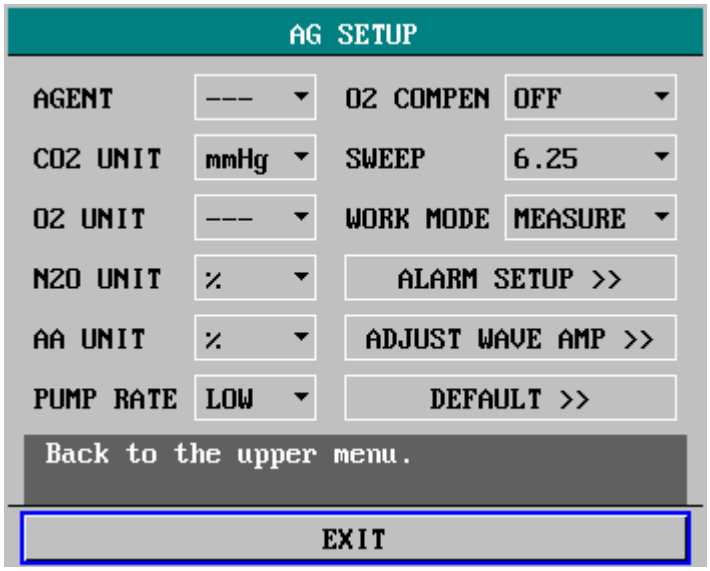


Figure 18-4 AG SETUP menu

In this menu, you can set the following items.

- Agent — Used to select the name of the anesthetic to be monitored, including AA, HAL, ENF, ISO, SEV and DES.

If you select the AION 02 AG module, the patient monitor cannot identify the anesthetic type. Therefore, you have to select the used anesthetic before using the AG module so that the AG module can conduct measurements normally.
If you select the AION 03 AG module, the used anesthetic will be automatically displayed here, so you need not set this item.

- CO2 UNIT — Options: mmHg, kPa and %.
- O2 UNIT — Options: mmHg, kPa and %.
- N2O UNIT — %
- AA UNIT — %
- PUMP RATE — Used to select the appropriate pump rate
  3 options: HIGH, MED, LOW
- O2 COMPEN — The options include: OFF, 30%, 40%, 50%, 60%, 70%, 80%, 90%, and 100%.

When the O_2 concentration exceeds 60% and it is not being monitored, turn on this switch.

- SWEEP — Used to select the speed to scan the screen waveforms. Options: 6.25mm/s and 12.5mm/s.
- WORK MODE — Options: MEASURE and STANDBY.

To monitor the anesthetic gas, select the MEASURE option. Otherwise, select the STANDBY option.

Alarm Setup Menu

Select ALARM SETUP >> in AG SETUP menu. The following menu appears.



Figure 18-5 Alarm Setup Menu

In the ALARM SETUP menu-1, you can set the following items.

- ALM — Alarm on/off status
  ON: When the AG has an alarm, the system will give alarm indications and save the alarm information.
  OFF: The system will not give alarm indications when an AG alarm occurs. Instead it will display ⚠ on the right of the GAS label in the parameter window.
- ALM LEV — Options: HIGH, MED and LOW.
- ALM REC — ON: The recorder outputs the alarm information in case an AG alarm occurs.
  OFF: The recorder does not output the alarm information in case an AG alarm occurs.
- EtCO2 ALM HI — Set the upper limit of $EtCO_2$ which triggers the alarm

- EtCO2 ALM LO Set the lower limit of $EtCO_2$ which triggers the alarm
- FiCO2 ALM HI Set the upper limit of $FiCO_2$ which triggers the alarm
- FiCO2 ALM LO Set the lower limit of $FiCO_2$ which triggers the alarm
- EtO2 ALM HI Set the upper limit of EtO_2 which triggers the alarm
- EtO2 ALM LO Set the lower limit of EtO_2 which triggers the alarm
- FiO2 ALM HI Set the upper limit of FiO_2 which triggers the alarm
- FiO2 ALM LO Set the lower limit of FiO_2 which triggers the alarm
- AWRR ALM HI Set the upper limit of AwRR which triggers the alarm
- AWRR ALM LO Set the lower limit of AwRR which triggers the alarm

Select OTHER SETUP >> in ALARM SETUP menu. The following menu appears.



Figure 18-6 ALARM SETUP menu

In the ALARM SETUP menu-2, you can set the following items.

- EtN2O ALM HI Set the upper limit of EtN_2O which triggers the alarm
- EtN2O ALM LO Set the lower limit of EtN_2O which triggers the alarm
- FiN2O ALM HI Set the upper limit of FiN_2O which triggers the alarm
- FiN2O ALM LO Set the lower limit of FiN_2O which triggers the alarm
- EtAA ALM HI Set the upper limit of EtAA which triggers the alarm
- EtAA ALM LO Set the lower limit of EtAA which triggers the alarm
- FiAA ALM HI Set the upper limit of FiAA which triggers the alarm

- FiAA ALM LO — Set the lower limit of FiAA which triggers the alarm
- APNEA ALM — Used to set up the apnea alarm time. Options: 20s, 25s, 30s, 35s and 40s.

NOTE

- **Never turn off APNEA alarm.**

Adjust Wave Amplitude Menu

Select ADJUST WAVE AMP>> in AG SETUP menu. The following menu appears.

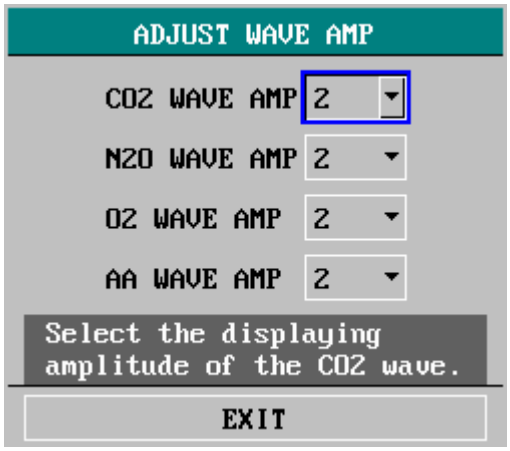


Figure 18-7 ADJUST WAVE AMP menu

In the ADJUST WAVE AMP menu, you can set the following items.

- CO2 WAVE AMP — Used to adjust the display amplitude of CO_2 waveform. Options: 1, 2, 3, 4, and 5.
- N2O WAVE AMP — Used to adjust the display amplitude of N_2O waveform. Options: 1, 2, 3, 4, and 5.
- O2 WAVE AMP — Used to adjust the display amplitude of O_2 waveform. Options: 1, 2, 3, 4, and 5.
- AA WAVE AMP — Used to adjust the display amplitude of AA waveform. Options: 1, 2, 3, 4, and 5.

Where, 1 indicates the minimum amplitude, and 5 indicates the maximum.

Default Menu

Select DEFAULT >> in AG SETUP menu. The AG DEFAULT CONFIG menu appears. In this menu, you can select FACTORY DEFAULT CONFIG or USER DEFAULT CONFIG. After selecting that, the system will prompt to confirm the selection.

18.4 Maintenance and Cleaning

⚠WARNING

- **Make sure that one patient sample line is used for only one patient.**

Occlusion handling

If the AG module passage is occluded, the screen will prompt "AG OCCLUSION". Following are a few examples of occlusion, which you may remove one by one until this message disappears.

Entrance occlusion

If the part at the entrance such as the filter, sample line or airway adapter is occluded by the condensed water, the system will prompt on the screen that the airway is occluded.

The optimal method to remove clogs of this kind is:

- Check the filter for clogs. If it is clogged, replace the bacteria filter at the entrance.
- Check the sample pipe for clogs or knots. Replace it if necessary.
- Check the airway adapter for water. If necessary, drain the water and install the adapter again.

Internal Occlusion

If the interior of the AG module is contaminated by the condensed water, the system will prompt on the screen that the airway is occluded.

The optimal method to remove clogs of this kind is:

1. Check, as usual, the entrance or the exit for clogs, and remove them if any.
2. If the occlusion still exists after step 1, check for the existence of interior occlusion. In this case, contact our Customer Service.

Removing Exhaust Gases from the System

Anesthetics: When using the CO_2 measurement on patients who are receiving or have recently received anesthetics, connect the outlet to a scavenging system, or to the anesthesia machine/ventilator, to avoid exposing medical staff to anesthetics.

To remove the sample gas to a scavenging system, connect an exhaust tube to the gas outlet connector of the module.

19 Accessories

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19.1 ECG Accessories

Description	PN
Monitoring Electrode (10 electrodes per pack)	0010-10-12304
Monitoring Electrode (3M 2249)	0509-10-00094
Monitoring Electrode (Pediatric, 3M 2245, 25 electrodes per pack)	9000-10-07469
Monitoring Electrode (Neonatal, 3M 2258-3, 3 electrodes per pack)	900E-10-04880
5 Lead Leadwires of Snap (LL-22305)	6000-10-02006
6 Pin 5 Lead ECG Cable (LL-2514)	6000-10-02007
6 Pin 5 Lead ECG Cable (LL-2540)	9000-10-05163
3 Lead Leadwires of Snap AHA (LL-22363)	9000-10-07445
6 Pin 3 Lead ECG Cable (LL-2325)	0509-10-00093
6P 5 Lead ECG Cable with no resistance AHA	0010-30-12240
6P 5 Lead ECG Cable IEC with no resistance	0010-30-12241
6P 3 Lead ECG Cable with no resistance AHA	0010-30-12242
6P 3 Lead ECG Cable IEC with no resistance	0010-30-12243
6P 5 Lead ECG Cable with 1K resistance AHA	0010-30-12244
6P 5 Lead ECG Cable with 1K resistance IEC	0010-30-12245
6P 3 Lead ECG Cable with 1K resistance AHA	0010-30-12246
6P 3 Lead ECG Cable with 1K resistance IEC	0010-30-12247
6P ECG Trunk Cable with no resistance	0010-30-12256
6P ECG Trunk Cable with 1K resistance	0010-30-12257
5 Lead AHA Leadwires of clip	0010-30-12262
3 Lead AHA Leadwires of clip	0010-30-12263
5 Lead IEC Leadwires of clip	0010-30-12264
3 Lead IEC Leadwires of clip	0010-30-12265
5 Lead AHA Leadwires of snap	0010-30-12266
3 Lead AHA Leadwires of snap	0010-30-12267
5 Lead IEC Leadwires of snap	0010-30-12268

Description	PN
3 Lead IEC Leadwires of snap	0010-30-12269
6Pin 3 Lead ECG trunk cable with 1K resistance	0010-30-12377
6Pin 3 Lead ECG trunk cable with no resistance	0010-30-12378
Neonate 3 Lead AHA leadwires of clip	0010-30-12381
Neonate 3 Lead IEC leadwires of clip	0010-30-12382
Pediatric 3 Lead AHA leadwires of clip	0010-30-12383
Pediatric 3 Lead IEC leadwires of clip	0010-30-12384
Pediatric 3 Lead AHA leadwires of snap	0010-30-12385
Pediatric 3 Lead IEC leadwires of snap	0010-30-12386
Mixed-length 5 Lead AHA leadwires of clip	0010-30-12387
Long 3 Lead AHA leadwires of clip	0010-30-12388
Mixed-length 5 Lead IEC leadwires of clip	0010-30-12389
Long 3 Lead IEC leadwires of clip	0010-30-12390
12 lead ECG trunk cable with 1K resistance AHA	0010-30-12421
12 lead ECG trunk cable with 1K resistance IEC	0010-30-12422
12 lead AHA limb leadwires of clip	0010-30-12423
12 lead IEC limb leadwires of clip	0010-30-12424
12 lead AHA limb leadwires of snap	0010-30-12425
12 lead IEC limb leadwires of snap	0010-30-12426
12 lead AHA chest leadwires of clip	0010-30-12427
12 lead IEC chest leadwires of snap	0010-30-12428
12 lead AHA chest leadwires of snap	0010-30-12429
12 lead IEC chest leadwires of clip	0010-30-12430

19.2 SpO_2 Accessories

19.2.1 Mindray SpO_2 Accessories

Description	PN
6Pin SpO_2 Cable	0010-20-42594
Adult Oxygen Sensor (Disposable, MAX-A, >30kg)	0010-10-12202
Pediatric Oxygen Sensor (Disposable, MAX-P, 10 to 50kg)	0010-10-12203
Infant Oxygen Sensor (Disposable, MAX-I, 3 to 20kg)	0010-10-12204
Neonatal/Adult Oxygen Sensor (Disposable, MAX-N, <3kg or >40kg)	0010-10-12205
DS-100A Adult Oxygen Sensor (Reusable)	9000-10-05161
OXI-P/I Pediatric/Infant Sensor and Sensor Wraps	9000-10-07308
OXI-A/N Adult/Neonatal Sensor and Sensor Wraps	9000-10-07336
Disposable SpO_2 Sensor for Adults (2211-1)	0010-10-12333
Disposable SpO_2 Sensor for Pediatrics (2211-2)	0010-10-12334
Disposable SpO_2 Sensor for Infants (2211-5)	0010-10-12335
Disposable SpO_2 Sensor for Neonates (2211-6)	0010-10-12336
518A Multisite SpO_2 Sensor (Reusable)	518A-30-90226
512B Finger SpO_2 Sensor (Reusable)	512B-30-90134
512D Finger SpO_2 Sensor (Reusable)	512D-30-90200
512E finger SpO_2 sensor	512E-30-90390
512G Soft SpO_2 Sensor, Pediatric, Finger	512G-30-90607
Small SpO_2 Ear Sensor (ES-3212-9)	0010-10-12392

19.2.2 Masimo SpO_2 Accessories

Description	PN
6Pin SpO_2 Cable	0010-30-42625
LNCS NeoPt – L Neonatal SpO_2 Adhesive Disposable Sensor	0010-10-42626
LNCS Neo – L Neonatal SpO_2 Adhesive Disposable Sensor	0010-10-42627
LNCS Inf – L Infant SpO_2 Adhesive Disposable Sensor	0010-10-42628
LNCS Pdt Pediatric SpO_2 Adhesive Disposable Sensor	0010-10-42629
LNCS Adt Adult SpO_2 Adhesive Disposable Sensor	0010-10-42630
LNCS DC-I Pediatric Resuable Sensor	0010-10-42634
LNCS DC-I Adult SpO2 Resuable Sensor	0010-10-42600
LNCS YI SpO2 Multisite Reusable Sensor and Single Use Attachment Wraps	0010-10-43016

19.2.3 Nellcor SpO_2 Accessories

Description	PN
6Pin SpO_2 Cable	0010-20-42595
Adult Oxygen Sensor (Disposable, MAX-A, >30kg)	0010-10-12202
Pediatric Oxygen Sensor (Disposable, MAX-P, 10 to 50kg)	0010-10-12203
Infant Oxygen Sensor (Disposable, MAX-I, 3-20kg)	0010-10-12204
Neonatal/Adult Oxygen Sensor (Disposable, MAX-N, <3kg or >40kg)	0010-10-12205
DS-100A Adult Oxygen Sensor (Reusable)	9000-10-05161
OXI-P/I Pediatric/Infant Sensor and Sensor Wraps	9000-10-07308
OXI-A/N Adult/Neonatal Sensor and Sensor Wraps	9000-10-07336

19.3 NIBP Accessories

Description	PN
NIBP Hose	509B-30-06259
Neonatal NIBP Hose	509B-30-06260
Infant 10 to 19cm Arm Circumference (CM1201)	0010-30-12157
Child 18 to 26cm Arm Circumference (CM1202)	0010-30-12158
Adult 25 to 35cm Arm Circumference (CM1203)	0010-30-12159
Large Adult 33 to 47cm Arm Circumference (CM1204)	0010-30-12160
Adult Thigh 46 to 66cm Arm Circumference (CM1205)	0010-30-12161
M1872A Disposable Cuff (Size #4, 7.1 to 13.1cm)	900E-10-04873
M1870A Disposable Cuff (Size #3, 5.8 to 10.9cm)	900E-10-04874
M1868A Disposable Cuff (Size #2, 4.3 to 8.0cm)	900E-10-04875
M1868A Disposable Cuff (Size #1, 3.1 to 5.7cm)	900E-10-04876

19.4 TEMP Accessories

Description	PN
REF 427 Reusable Temperature Probe -Skin (Pediatric)	0010-10-12124
REF 401 Reusable Temperature Probe -Esophagesal /Rectal (Adult)	0509-10-00095
REF 402 Reusable Temperature Probe -Esophagesal /Rectal (Pediatric)	6000-10-01969
REF 409B Reusable Temperature Probe -Skin (Adult)	900E-10-04881
Adult Reusable Esophageal/Rectal Temperature Probe	0011-30-90440
Pediatric/Neonatal Reusable Esophageal/Rectal Temperature Probe	0011-30-90441
Adult Reusable Skin-surface Temperature Probe	0011-30-90442
Pediatric/Neonatal Reusable Skin-surface Temperature Probe	0011-30-90443
Reusable Temperature Probe Extension Cable	0011-30-90444
Disposable Esophageal/Rectal Temperature Probe	0011-30-90446
Disposable Skin-surface Temperature Probe	0011-30-90447

19.5 IBP Accessories

Description	PN
Truware Disposable Pressure Transducer (PX260)	0010-10-12176
Transducer Interface Cable (PX1800/896019021)	0010-10-12177
Transducer Mount (DTH4)	0010-10-12192
Transducer Mount (DTSC)	0010-10-12193
Truware Disposable Pressure Transducer	0010-10-12208
Intracranial Pressure Transducer (ICT/B, Gaeltec)	0010-10-12151
6Pin ICP Cable	0010-21-12154
Transducer Interface Cable (Reusable, TC-VTK)	6000-10-02106
Disposable Pressure Transducer (DT-4812)	6000-10-02107
Transducer/manifold mount (BD)	0010-10-12156
Disposable pressure Transducer (abbott)	0010-10-42638
6Pin IBP cable (42661-14,abbott)	0010-10-42640
Steady rest for IBP Transducer and Clamp	M90-000133---
Steady clip for IBP transducer	M90-000134---

19.6 CO Accessories

Description	PN
IT sensor (OHMEDA P /N: SP4042 'BD')	6000-10-02079
IT sensor housing (OHMEDA P /N: SP5045 'BD')	6000-10-02080
CO syringe (93610 'EDWARTDS')	0010-10-12317
12CC contrl syringe W /1CC Stop W /Rotator (Medex)	6000-10-02081
6Pin CO cable	900E-30-04952
Dilution hose (131HF7 ' EDWARTDS 'or 'Baxter')	6000-10-02183

19.7 CO_2 Accessories

19.7.1 Mindray CO_2 Accessories

Description	PN
Adult Nasal CO2 Sample Cannula (with7'line, 4000)	M02A-10-25937
Pediatric Nasal CO2 Sample Cannula (with7'line, 4100)	M02A-10-25938
DRYLINE Airway Adapter, Straight (P/N: 60-14100-00)	9000-10-07486
Aion DRYLINE Water TrapAdult (P/N: 60-13100-00)	9200-10-10530
Sampling Line, Adult 2.5m (P/N: 60-15200-00)	9200-10-10533

19.7.2 Oridion CO_2 Accessories

Description	PN
FilterLine H Set Adult/Pediatric (XS04624)	0010-10-42561
FilterLine H Set Infant/Neonatal (006324)	0010-10-42562
FilterLine Set Adult/Pediatric Long (007768)	0010-10-42563
FilterLine H Set Adult/Pediatric Long (007737)	0010-10-42564
FilterLine H Set Infant/Neonatal Long (007738)	0010-10-42565
Smart CapnoLine Plus Adult/Intermediate (009818)	0010-10-42566
Smart CapnoLine Pediatric (007266)	0010-10-42567
Smart CapnoLine Plus O2 Adult / Intermediate (009822)	0010-10-42568
Smart CapnoLine O2 Pediatric (007269)	0010-10-42569
Smart CapnoLine Plus O2 Adult/ Intermediate Long (009826)	0010-10-42570
Smart CapnoLine O2 Pediatric Long (007743)	0010-10-42571
CapnoLine H Adult (008177)	0010-10-42572
CapnoLine H Pediatric (008178)	0010-10-42573
CapnoLine H Infant/Neonatal (008179)	0010-10-42574
CapnoLine H O2 Adult (008180)	0010-10-42575

Description	PN
CapnoLine H O2 Pediatric (008181)	0010-10-42576
NIV-Line Adult (008174)	0010-10-42577
NIV-Line Pediatric (008175)	0010-10-42578

19.7.3 Welch Allyn CO_2 Accessories

Description	PN
Mainstream Sensor II (P/N 000.59000)	9000-10-07299
Airway Adapter, Adult (P/N 000.91060)	9000-10-07301
Airway Adapter, LDS (P/N 000.91070)	9000-10-07302

19.8 AG Accessories

Description	PN
DRYLINE Airway Adapter, Straight (P/N: 60-14100-00)	9000-10-07486
DRYLINE Water Trap Adult (P/N: 60-13100-00)	9200-10-10530
Sampling Line, Adult 2.5m(P/N：60-15200-00)	9200-10-10533
DRYLINE Airway Adapter, Elbow (P/N: 60-14200-00)	9000-10-07487
Sampling SATRAIGHT CTEE	9200-10-10593
SAMPLING ELBOW (P/N 000.91167)	9000-10-07297
Sampling Line Neonate2.5m (P/N: 60-15300-00)	9200-10-10555
DRYLINE WATER TRAP NEONATER (P/N: 60-13200-00)	9200-10-10574

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Appendix A Product Specifications

A.1 Safety Classifications

Type of protection against electric shock	Class I with internal electric power supply. Where the integrity of the external protective earth (ground) in the installation or its conductors is in doubt, the equipment shall be operated from its internal electric power supply (batteries)
Degree of protection against electric shock	Sidestream CO_2/AG: BF (defibrillation proof) ECG/RESP/TEMP/SpO_2/NIBP/IBP/ CO/mainstream CO_2: CF (defibrillation proof)
Degree of protection against hazards of ignition of flammable anesthetic mixtures	Not protected (ordinary)
Degree of protection against harmful ingress of water	Not protected (ordinary)
Mode of operation	Continuous
Equipment type	Portable

A.2 Environmental Specifications

Operating temperature	0 to 40℃ 5 to 35℃ (With Mindray CO_2 module) 10 to 40℃ (With Welch Allyn CO_2 module) 5 to 35℃ (With Oridion CO_2 module) 10 to 35℃ (With AION AG module)
Operating humidity	15 to 95%, noncondensing
Altitude	-500 to 4600m (-1640 to 15092 feet) -305 to 3014m (-1000 to 9889 feet) (with CO_2, AG, Masimo or Nellcor SpO_2 module)
Storage temperature	–20 to 60℃
Storage humidity	10 to 95%, noncondensing

A.3 Power Source Specifications

AC mains	
Input voltage	100 to 240V
Frequency	50/60Hz
Power	140VA
Fuse	T 3A
Internal battery	
Number of batteries	2
Type	Sealed lead-acid battery or lithium-ion battery
Time to shutdown	5 to 15min (after the first low-power alarm)
Sealed lead-acid battery	
Nominal voltage	12VDC
Capacity	2.3Ah
Operating time	48 minutes or 120 minutes typical when powered by one or two new fully-charged batteries respectively (25℃, ECG, SpO2, NIBP measurement per 15 minutes).
Charge time	A maximum of 6 h for each battery, and a maximum of 12h for both (in the running status or standby mode)
Lithium battery	
Rated voltage	11.1VDC
Capacity	4.4Ah
Operating time	120 minutes or 300 minutes typical when powered by one or two new fully-charged batteries respectively (25℃, ECG, SpO2, NIBP measurement per 15 minutes).
Charge time	A maximum of 6.5h (in the running status or standby mode)

A.4 Hardware Specifications

Physical	
Size	318 × 270 × 137mm (width×height×depth)
Weight	Different due to different configurations Standard configuration: 4.7kg Maximum weight: ≤ 7.5kg
Display	
Type	Color TFT LCD
Size	10.4 inches (diagonal)
Resolution	800×600 pixels
Recorder	
Type	Thermal dot array
Horizontal resolution	160 dots/cm (at 25 mm/s recording rate)
Vertical resolution	80 dots/cm
Width of the recorder paper	50 mm
Length of the recorder paper	30 m
Recording rate	25 mm/s, 50 mm/s
Recorded waveforms	2
LED indicator	
Alarm indicator	1 (yellow and red)
AC power indicator	1 (green)
Audio indicator	
Speaker	Giving audio alarms, keypad tones, and heartbeat/pulse tone. Supporting PITCH TONE and multi-level volume. Audio alarms comply with EN475 and IEC60601-1-8.
Control	
Control knob	1 knob, which can be rotated clockwise/counterclockwise or pressed.
Button	7 buttons: POWER, MAIN, FREEZE, PAUSE, RECORD, NIBP, MENU

Connectors	
Power supply	1 AC power connector
Parameter	ECG, RESP, TEMP, SPO2, NIBP, IBP, CO, CO2, AG
Network	1 standard RJ45 network connector, 100 BASE-TX
VGA	1 standard color VGA monitor connector, 15-PIN D-sub
Auxiliary output	1 BNC connector
Equipotentiality	1 equipotential grounding connector

A.5 Wireless network

<table>
<tr><td>Standards</td><td colspan="7">IEEE 802.11b, Wi-Fi compatible</td></tr>
<tr><td>Frequenct range</td><td colspan="7">2.412 to 2.462GHz</td></tr>
<tr><td rowspan="3">Operating channel</td><td>China</td><td>America</td><td>Canada</td><td>Europe</td><td>Spain</td><td>France</td><td>Japan</td></tr>
<tr><td colspan="4">1 to 11</td><td colspan="2">10, 11</td><td>2</td></tr>
<tr><td colspan="7">For other country, please refer to your local law.</td></tr>
<tr><td>Safe distance</td><td colspan="7">10m (a circle centering AP with the diameter of 10m)</td></tr>
<tr><td>Maximum data rate</td><td colspan="7">11Mbps</td></tr>
</table>

A.6 Data Storage

Trend data	Long trend: 96 hours, resolution 1min, 5 min or 10 min. Short trend: 1 hour, resolution 1 s or 5 s.
Alarm events	70 alarm events and associated waveforms (with user selectable waveform length 8s, 16 or 32).
ARR events	80 ARR events and associated waveforms with 8s wavelength.
NIBP measurements	800 NIBP groups, including systolic pressures, mean pressures, diastolic pressures and measurement time.

A.7 Signal Output Specifications

Standards	Meets the requirements of EC60601-1 for short-circuit protection and leakage current
Output impedance	50Ω
ECG analog output	
Bandwidth (-3dB; reference frequency: 10Hz)	Diagnostic mode: 0.05 to 100Hz(12-lead: 0.05 to 150Hz) Monitor mode: 0.5 to 40Hz Surgery mode: 1 to 20Hz
Signal delay	≤ 25ms
Maximum propagation delay	25ms (In DIAGNOSTIC mode, NOTCH is OFF)
Sensitivity	1V/mV±5%
PACE rejection/enhancement	No pace rejection or enhancement
IBP analog output	
Bandwidth	0 to 12.5 Hz (-3dB, reference frequency: 1Hz)
Maximum propagation Delay	55ms (the filter function is disabled)
Sensitivity	1 V/100mmHg±5%
Nurse call output	
Driver	Relay
Electrical specifications	≤60W, ≤2A, ≤36VDC, ≤25VAC
Isolation voltage	> 1500 VAC
Signal type	Normally open or normally closed, selectable
Defibrillator synchronization pulse	
Maximum time delay	35ms (R-wave peak to leading edge of the pulse)
Amplitude	3.5 V (min) at 3 mA sourcing; 0.8 V (max) at 1 mA sinking
Pulse width	100 ms ±10%
Rising and falling time	< 3ms
VGA	
Signal	RGB: 0.7 Vp-p/75Ω; Horizontal/vertical synchronization: TTL level

A.8 ECG Specifications

Lead type	3-lead (1 channel): I, II, III 5-lead (2 channels): I, II, III, aVR, aVL, aVF and V 12-lead (8 channels): I, II, III, avR, avL, avF, V1-V6
Lead naming style	AHA, EURO
Sensitivity selection	1.25mm/mV (×0.125), 2.5mm/mV (×0.25), 5mm/mV (×0.5), 10mm/mV (×1), 20mm/mV (×2) and auto
Sweep speed	12.5mm/s, 25mm/s, 50mm/s
Bandwidth (– 3dB)	Diagnostic mode: 0.05 to 100Hz (12-lead: 0.05 to 150Hz) Monitor mode: 0.5 to 40Hz Surgery mode: 1 to 20Hz
Common mode rejection	Diagnostic mode: ≥90 dB (12-lead: >95 dB) Monitor mode: ≥105 dB Surgery mode: ≥105 dB (The notch filter is turned off.)
Differential input impedance	≥ 5MΩ
Input signal range	±8mV (peak-to-peak value)
DC offset voltage	±300mV (12-lead: ±500mV)
Patient leakage current	< 10uA
Recovery time after defibrillation	< 3s
Calibration signal	1mV (peak-to-peak value), precision: ±5%
HR	
Measurement range	Neonate: 15 to 350 BPM Pediatric: 15 to 350 BPM Adult: 15 to 300 BPM
Resolution	1 BPM
Precision	±1BPM or ±1%, whichever is greater.
Sensitivity	200μV (lead II)

Response time to heart rate changes	Meets the requirement of ANSI/AAMI EC13-2002: Section 4.1.2.1 f). Less than 11 sec for a step increase from 80 to 120 BPM Less than 11 sec for a step decrease from 80 to 40 BPM
Response time of tachycardia alarm	When tested in accordance with ANSI/AAMI EC13-2002 Section 4.1.2.1 g, the response time is as follows. Figure 4ah – range: 15.7 to 19.2s, average: 17.4s 4a – range: 5.7 to 8.5s, average: 7.5s 4ad – range: 3.6 to 5.1s, average: 4.2s Figure 4bh – range: 11.5 to 14.7s, average: 12.9s 4b – range: 4 to 14s, average: 7.2s 4bd – range: 6.6 to 14.5s, average: 10.5s
Pace pulse	
Pulse indicator	Pace pulses meeting the following conditions are marked by the PACE indicator. Amplitude: ±4 to ±700mV Width: 0.1ms to 2ms Rise time: 10us to 100µs
Pulse rejection	When tested in accordance with the ANSI/AAMI EC13-2002: Sections 4.1.4.1 and 4.1.4.3, the heart rate meter rejects all pulses meeting the following conditions. Amplitude: ±2 to ±700mV Width: 0.1ms to 2ms Rise time: 10us to 100µs Min. input slew rate: 50V/s RTI
ST segment measurement	
Measurement range	– 2.0 to +2.0 mV
Precision	– 0.8 to +0.8mV: ±0.02mV or ±10%, whichever is greater. Beyond this range: Undefined.
Update period	10s
Arrhythmia analysis	
Type	ASYSTOLE, VFIB/VTAC, PVC, COUPLET, VT>2, BIGEMINY, TRIGEMINY, R ON T, MISSED BEATS, TACHY, BRADY, PNC and PNP

A.9 RESP Specifications

Measurement technique	Thoracic impedance	
Lead	Optional: lead I and lead II; default lead II	
Differential input impedance	> 2.5MΩ	
Respiration impedance test range	0.3 to 3Ω	
Excitation current	< 300μA	
Baseline impedance range	200 to 2500Ω (using an ECG cable with 1kΩ resistance)	
Bandwidth	0.2 to 2Hz (-3 dB)	
Sweep speed	6.25 mm/s, 12.5 mm/s, 25 mm/s	
RR		
Measurement range	Adult: Pediatric/neonate:	0 to 120 BrPM 0 to 150 BrPM
Resolution	1 BrPM	
Precision	7 to 150 BrPM: 0 to 6 BrPM:	±2 BrPM or ±2%, whichever is greater. Undefined.
Apnea alarm delay	10 to 40s	

A.10 SpO_2 Specifications

A.10.1 Mindray SpO_2 Module

SpO_2	
Measurement range	0 to 100%
Resolution	1%
Precision	70 to 100%: ±2 % (adult/pediatric, non-motion conditions) 70 to 100%: ±3 % (neonate, non-motion conditions) 70 to 100%: ±3 % (in motion conditions) 0% to 69%: Undefined.
Refreshing rate	1s
PR	
Measurement range	20 to 254bpm
Resolution	1bpm
Precision	±3 bpm (non-motion conditions) ±5 bpm (in motion conditions)
Refreshing rate	1s

A.10.2 Masimo SpO_2 Specifications

SpO_2	
Measurement range	1 to 100%
Resolution	1%
Precision	70 to 100%: ±2% (adult/pediatric, non-motion conditions) 70 to 100%: ±3% (neonate, non-motion conditions) 70 to 100%: ±3% (in motion conditions) 0% to 69%: Undefined.
Refreshing rate	1s
PR	
Measurement range	25 to 240bpm

Resolution	1bpm
Precision	±3bpm (non-motion conditions) ±5bpm (in motion conditions)
Refreshing rate	1s

A.10.3 Nellcor SpO_2 Specifications

SpO_2 measurement range and precision	Sensor	Range	Precision*
	MAX-A, MAX-AL, MAX-N, MAX-P, MAX-I and MAX-FAST	70 to 100% 0% to 69%	±2% Undefined
	OxiCliq A, OxiCliq N, OxiCliq P, OxiCliq I	70 to 100% 0% to 69%	±2.5% Undefined
	D-YS, DS-100A, OXI-A/N and OXI-P/I	70 to 100% 0% to 69%	±3% Undefined
	MAX-R, D-YSE and D-YSPD	70 to 100% 0% to 69%	±3.5% Undefined
PR measurement range and precision	20 to 250bpm: ±3bpm 251 to 300bpm: Undefined		
Refreshing rate	1s		
*: When sensors are used on neonatal subjects as recommended, the specified precision range is increased by ±1%, to account for the theoretical effect on oximeter measurements of fetal hemoglobin in neonatal blood.			

A.11 NIBP Specifications

Measurement technique	Auto oscillation			
Displayed parameters	Systolic pressure, diastolic pressure and mean pressure			
Mode of operation	Manual, auto and continuous			
Measurement interval in auto mode	1/2/3/4/5/10/15/30/60/90/120/180/240/480 minutes			
Measurement time in continuous mode	5 minutes			
Measurement range in normal mode	mmHg	Adult	Pediatric	Neonate
	Systolic pressure	40 to 270	40 to 200	40 to 135
	Diastolic pressure	10 to 210	10 to 150	10 to 100
	Mean pressure	20 to 230	20 to 165	20 to 110
Measurement precision	Maximum average error: ±5mmHg Maximum standard deviation: 8mmHg			
Resolution	1mmHg			
Over-pressure protection	Adult: 297±3 mmHg Pediatric: 240±3 mmHg Neonate: 147±3 mmHg			

A.12 TEMP Specifications

Number of channels	2
Displayed parameters	T1, T2 and TD
Measurement range	0 to 50°C (32 to 122°F)
Resolution	0.1°C
Precision	0.1°C (excluding the sensor) ±0.2°C (including the YSI 400 series sensor)
Update period	1s
Minimum time for accurate measurement	Body surface: < 100s Body cavity: < 80s (YSI 400 series sensor)

A.13 IBP Specifications

Number of channels	2	
Pressure labels	ART, PA, CVP, RAP, LAP, ICP, P1 and P2	
Measurement range	ART	0 to 300 mmHg
	PA	– 6 to 120 mmHg
	CVP/RAP/LAP/ICP	– 10 to 40 mmHg
	P1/P2	– 50 to 300 mmHg
Resolution	1 mmHg	
Precision	±2% or ±1mmHg, whichever is greater	
Update period	1s	
Pressure transducer		
Sensitivity	5 uV/V/mmHg	
Impedance range	300 to 3000Ω	

A.14 CO Specifications

Measurement technique	Thermal dilution	
Calculated parameter	CO, hemodynamics	
Measurement range	CO	0.1 to 20l/min
	TB	23 to 43°C
	TI	0 to 27°C
Resolution	CO: TB, TI:	0.1 l /min 0.1°C
Precision	CO: TB, TI:	±5% or ± 0.1 l /min 0.1°C
Alarm range	TB:	23 to 43°C

A.15 CO_2 Specifications

Measurement technique	Infrared absorption technique
Measurement mode	Sidestream, microstream or mainstream (optional)
Displayed parameter	EtCO2, FiCO2, Respiration Rate
CO2 function	Meet the requirements of EN864 and ISO9918.

A.15.1 Mindray CO_2 Specifications

CO2 measurement range	0 to 99mmHg
Precision*	0 to 40 mmHg: ±2mmHg 41 to 76 mmHg: ±5% 77 to 99 mmHg: ±10%
Deflation rate	100, 150ml/min
Precision of deflation rate	15%
Start-up time of CO2 module	< 1min. The module enters the warming up status after the startup. Ten minutes later, it enters the ready-to-measure status.
AwRR measurement range	0 to 120 BrPM
Precision	0 to 70 BrPM: ±2 BrPM > 70 BrPM: ±5 BrPM
Response time	< 240 ms (10 to 90%)
Delay time	< 2s (Length of sampling tube: 7 feet; inner diameter: 0.055 inches; sampling flow: 150ml/min)
Apnea alarm delay	AwRR: 10 to 40 s
* Conditions for measurements in typical precision: The measurement is started after the preheating mode of the module; Ambient pressure: 750mmHg to 760mmHg; room temperature: 22℃ to 28℃; The gas under test is dry, and the balance gas is N2; The deflation rate is 150ml/min, the respiration rate is no greater than 30BrPM, with a fluctuation less than ±3BrPM, and the inhale interval/exhale interval is 1:2; In other conditions, the measurement precision should meet the requirements of EN864 or ISO9918: ±4mmHg (0 to 40mmHg) or ±12% of the reading (41 to 99mmHg)	

A.15.2 Oridion CO_2 Specifications

CO_2 measurement range	0 to 99mmHg
Precision*	0 to 38 mmHg: ±2mmHg 39 to 99 mmHg: ±5% + 0.08%× (reading - 38mmHg)
Resolution	Waveform: 0.1mmHg Value: 1mmHg
Flow rate	$50^{-7.5}_{+15}$ ml/min
Initialization time	30s (typical)
Response time	2.9s (typical)
Delay time	2.7s (typical)
AwRR measurement range	0 to 150 BrPM
AwRR measurement precision	0 to 70BrPM: ±1BrPM 70 to 120BrPM: ±2BrPM 121 to 150BrPM: ±3BrPM
Apnea alarm delay	AwRR: 10 to 40s
* Precision applies for breath rates of up to 80 bpm. For breath rates above 80 bpm, accuracy complies with EN 864/ISO 9918 (4 mmHg or ±12% of reading whichever is greater) for $EtCO_2$ values exceeding 18 mmHg. To achieve the specified accuracies for breath rates above 60 breaths/minute, the Microstream® FilterLine H Set for Infant/Neonatal (p/n 006324) must be used. The accuracy specification is maintained to within 4% of the values indicated in the above table in the presence of interfering gases according to EN864 Section Eleven, Part 101.	

A.15.3 Welch Allyn CO_2 Specifications

CO2 measurement range	0 to 99mmHg
Precision*	0 to 40 mmHg: ±2mmHg 41 to 76 mmHg: ±5% 77 to 99 mmHg: ±10%
Resolution	1mmHg
Refreshing rate	1s
Start-up time	< 80s (ambient temperature: 25℃; preheating power of transducer: 5W)
Response time	100ms (10% to 90 %)
Calibration	Daily calibration is unnecessary
Calibration stability	There is a difference (< 1%) from the precison criteria after a 12-month continuous service time
Alarm range	0 to 99 mmHg
AwRR measurement range	0 to 150 BrPM
AwRR alarm range	0 to 150 BrPM
Apnea alarm delay	AwRR: 10 to 40 s
* Precision specification is based upon the following standard airway conditions: sensor 42℃; airway adapter temperature 33℃; water vapor pressure 38 mmHg; standard gas mixture equals CO2 in balance air; fully hydrated at 33℃; atmospheric pressure 760 mmHg; airway flow rate 60 cc/min.	

A.16 AG Specifications

Measurement technique	Infrared absorption		
Measurement mode	Side stream		
AG functions	Meets requirements of ISO9918, ISO11196, EN12598 and ISO7767		
Warm-up time	45 seconds (warming-up status) 10 minutes (ready-to-measure status)		
Sampling flow (sidestream)	Adult/Pediatric	120, 150, 200 ml/minute (user-selectable)	
	Neonatal	70, 90, 120 ml/minute (user-selectable)	
Gas type	CO_2, N_2O, O_2 (optional), Des, Iso, Enf, Sev, Hal		
Measurement range	CO_2: 0 to 30% N_2O: 0 to 105% Des: 0 to 30% Sev: 0 to 30% Enf, Iso, Hal: 0 to 30% O_2: 0 to 105% AwRR: 2 to 100 BrPM		
Resolution	CO_2: 1 mmHg AwRR: 1 BrPM		
Precision	Gas	Range (%REL)	Precision (%ABS)
	CO2	0 to 1	±0.1
		1 to 5	±0.2
		5 to 7	±0.3
		7 to 10	±0.5
		> 10	Not specified
	N2O	0 to 20	±2
		20 to 100	±3
	Des	0 to 1	±0.15
		1to 5	±0.2
		5 to 10	±0.4
		10 to 15	±0.6

		15 to 18	±1
		>18	Not specified
	Sev	0 to 1	±0.15
		1 to 5	±0.2
		5 to 8	±0.4
		> 8	Not specified
	Enf, Iso, Hal	0 to 1	±0.15
		1 to 5	±0.2
		> 5	Not specified
	O2 (Optional)	0 to 25	±1
		25 to 80	±2
		80 to 100	±3
	AwRR	2 to 60 BrPM	±1 BrPM
		> 60 BrPM	Not specified
Alarm range	CO2: AwRR:	0 to 10 % (0 - 76 mmHg) 2 to 100 BrPM	
Apnea alarm delay	AwRR：	20 - 40 s	
Refreshing rate	1s		
Calibration	Yearly calibration requested.		
Calibration stability	After module being used for 12 consective months, the error is < 1%		
Rise time (10 % to 90 %) Sampling flow 120ml/min, using the DRYLINE™ water trap and neonatal DRYLINE™ sampling line (2.5m)	CO_2	250 ms (fall time 200 ms)	
	N_2O	250 ms	
	O_2	600ms	
	HAL, ISO, SEV, DES	300 ms	
	ENF	350 ms	
Rise time (10 % to 90 %) Sampling flow 200ml/min, using the DRYLINE™ water trap and adult DRYLINE™ sampling line (2.5m)	CO_2	250 ms (fall time 200 ms)	
	N_2O	250 ms	
	O_2	500ms	
	HAL, ISO, SEV, DES	300 ms	
	ENF	350 ms	
Delay time	< 4s		

Appendix B EMC

The equipment meets the requirements of IEC 60601-1-2:2001.

NOTE

- **Use of accessories, transducers, and cables other than those specified may result in increased emission and/or decreased immunity of the equipment.**
- **The equipment should not be used adjacent to or stacked with other equipment, and if adjacent or tacked use is necessary, the equipment should be observed to verify normal operation in the configuration in which it will be used.**
- **The equipment needs special precautions regarding EMC and needs to be installed and put into service according to the EMC information provided below.**
- **The equipment may be interfered with by other equipment, even if that other equipment complies with CISPR emission requirements.**
- **Operation of the device, in the case that the patient physiological signal is lower than the minimum amplitude and/or value specified in the product specifications, may cause inaccurate results.**

TABLE C-1

Guidance and MINDRAY declaration — electromagnetic emissions		
The equipment is intended for use in the electromagnetic environment specified below. The customer or the user of the equipment should assure that it is used in such an environment.		
Emissions test	**Compliance**	**Electromagnetic environment — guidance**
RF emissions CISPR 11	Group1	The equipment uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class A	The equipment is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic Emissions IEC61000-3-2	Class A	
Voltage Fluctuations/Flicker Emissions IEC 61000-3-3	Compliance	

TABLE C-2

Guidance and MINDRAY declaration — electromagnetic immunity			
The equipment is intended for use in the electromagnetic environment specified below. The customer or the user of the equipment should assure that it is used in such an environment.			
Immunity test	**IEC 60601 Test level**	**Compliance level**	**Electromagnetic environment — guidance**
Electrostatic Discharge (ESD) IEC 61000-4-2	±6 kV contact ±8 kV air	±6 kV contact ±8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast Transient/burst IEC 61000-4-4	±2 kV for power supply lines ±1 kV for input/output lines (>3m).	±2 kV for power supply lines ±1 kV for input/output lines (>3m)	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±1 kV differential mode ±2 kV common mode	±1 kV different mode ±2 kV common mode	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, Short interruptions and voltage variation on power supply input lines IEC 61000-4-11	<5% U_T (>95% dip in U_T) for 0.5 cycle 40% U_T (60% dip in U_T) for 5 cycle 70% U_T (30% dip in U_T) for 25 cycle <5% U_T (>95% dip in U_T) for 5 sec	<5% U_T (>95% dip in U_T) for 0.5 cycle 40% U_T (60% dip in U_T) for 5 cycle 70% U_T (30% dip in U_T) for 25 cycle <5% U_T (>95% dip in U_T) for 5 sec	Mains power quality should be that of a typical commercial or hospital environment. If the user of our product requires continued operation during power mains interruptions, it is recommended that our product be powered from an uninterruptible power supply or a battery.
Power frequency (50/60 HZ) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.

U_T is the A.C. mains voltage prior to application of the test level.

TABLE C-3

<table>
<tr><th colspan="4">Guidance and MINDRAY declaration — electromagnetic immunity</th></tr>
<tr><td colspan="4">The equipment is intended for use in the electromagnetic environment specified below.
The customer or the user of the equipment should assure that it is used in such an environment</td></tr>
<tr><th>Immunity test</th><th>IEC 60601 Test level</th><th>Compliance level</th><th>Electromagnetic environment — guidance</th></tr>
<tr><td>Conduced RF IEC 61000-4-6</td><td>3 Vrms
150kHz to 80MHz</td><td>3 Vrms</td><td rowspan="2">Portable and mobile RF communications equipment should be used no closer to any part of the equipment, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.
Recommended separation distance
$d = 1.2 \times \sqrt{P}$
$d = 1.2 \times \sqrt{P}$ 80 MHz to 800 MHz
$d = 2.3 \times \sqrt{P}$ 800 MHz to 2.5GHz
where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m).
Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey, [a] should be less than the compliance level in each frequency range [b] Interference may occur in the vicinity of equipment marked with the following symbol:  </td></tr>
<tr><td>Radiated RF IEC 61000-4-3</td><td>3 V/m
80MHz to 2.5GHz</td><td>3V/m</td></tr>
<tr><td colspan="4">Note — At 80 MHz and 800 MHz, the higher frequency range applies.
Note — These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.</td></tr>
<tr><td colspan="4">[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the equipment is used exceeds the applicable RF compliance level above, the equipment should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the equipment.
[b] Over the frequency ranges 150kHz to 80MHz, field strengths should be less than 3V/m.</td></tr>
</table>

TABLE C-4

Recommended separation distances between portable and mobile RF communication and the equipment			
The equipment is intended for use in an electromagnetic environment in which radiated RF disturbance are controlled. The customer or the user of the equipment can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communication equipment (transmitters) and the equipment as recommended below, according to the maximum output power of the communication equipment.			
Rated Maximum Output power of Transmitter W (Watts)	**Separation Distance According to Frequency of Transmitter M (Meters)**		
	150kHz -80MHz $d = 1.2\sqrt{P}$	80MHz -800MHz $d = 1.2\sqrt{P}$	800MHz -2.5GHz $d = 2.3\sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.37	0.37	0.74
1	1.17	1.17	2.34
10	3.69	3.69	7.38
100	11.67	11.67	23.34
For transmitters at a maximum output power not listed above, the recommended separation distanced in meters (m) can be determined using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer. Note — At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies. Note — These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			

Appendix C Alarm Messages and Prompt Information

C.1 Physiological Alarm Messages

Note: XX represents the parameters being monitored, such as HR, RR, SpO_2, etc. The "L" field indicates the alarm level, and 1 means high, 2 means medium, 3 mean low, * means the level is user-adjustable.

Alarm messages	L	Cause	Measure
XX TOO HIGH	2*	XX value exceeds the upper alarm limit.	Make sure the alarm limits are appropriate for the patient, and check the patient's condition.
XX TOO LOW	2*	XX value exceeds the lower alarm limit.	
ECG LOST	1	The ECG signal is so weak that the monitor can't perform ECG analysis.	Check the connection of the patient cable and lead wires, and then check the patient's condition.
RESP ARTIFACT	1	The patient's heartbeat interferes with his respiration. The respiration rate cannot be measured correctly.	
NO PULSE	1	The pulse signal of the patient is so weak that the monitor cannot perform pulse analysis.	
CO_2 APNEA	1	The respiration signal of the patient is so weak that the monitor cannot perform respiration analysis.	
RESP APNEA	1		
ASYSTOLE	1*	The asystole arrhythmia event occurs to the patient.	
VFIB/VTAC	1*	The ventricular tachycardia or ventricular fibrillation arrhythmia event occurs to the patient.	
R ON T	2*	The R ON T arrhythmia event occurs to the patient.	
VT > 2	2*	The VT>2 arrhythmia event occurs to the patient.	
COUPLET	2*	The couplet arrhythmia event occurs to the patient.	
PVC	2*	The PVC arrhythmia event occurs to the patient.	
BIGEMINY	2*	The bigeminy arrhythmia event occurs to the patient.	
TRIGEMINY	2*	The trigeminy arrhythmia event occurs to the patient.	
TACHY	2*	The patient is suffering from tachycardia.	
BRADY	2*	The patient is suffering from bradycardia.	
PNC	2*	No pacer signal is captured.	
PNP	2*	The pacemaker is not paced.	
MISSED BEATS	2*	The arrhythmia event of missed beats occurs to the patient.	

C.2 Technical Alarm Messages

Note: XX represents the parameter modules like ECG, NIBP and SpO_2, or the parameters being monitored like HR, PR and SpO_2.
The A field indicates whether an alarm can be completely cleared; the B field indicates whether the visual and audible indications of an alarm can be cleared; the "L" field indicates the alarm level, and 1 means high, 2 means medium, 3 mean low, * means the level is user-adjustable.

C.2.1 General Alarm Messages of Parameter Modules

Alarm message	**A**	**B**	**L**	**Cause**	**Measure**
XX INIT ERR N	Yes	No	1	XX module initialization error N	Restart the monitor. If the error remains, contact our company for repair.
Note: N stands for the error number.					
XX COMM STOP	No	No	1	Failure in communication between XX module and the main board.	
XX COMM ERR	Yes	No	1	Error in communication between XX module and the main board.	
XX ALM LMT ERR	No	No	1	The alarm limit of the XX parameter is changed inadvertently.	If the error remains, contact our company for repair.
XX EXCEED	No	No	1	The measured XX parameter value exceeds the measurement range.	

C.2.2 ECG Module Alarm Messages

Alarm message	**A**	**B**	**L**	**Cause**	**Measure**
ECG LEAD OFF	No	Yes	3	The ECG lead is not connected correctly.	Check for correct connection of the leadwires.
ECG X LEAD OFF	No	Yes	3		
Note: X represents the leadwires, V, LL, RL, LA and RA, as per AHA standard, or C, L, F, R and N as per IEC standard.					
ECG NOISE	No	No	3	Large interference signals appear on the ECG signal.	Make sure the leadwires are correctly connected. Check the patient for severe motion.
ECG CH1 SELFTEST ERR	Yes	No	1	An error occurs in the ECG initialization.	Restart the monitor. If the error remains, contact our company for repair.

C.2.3 RESP Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
RESP DISTURBED	No	No	3	The module circuit is disturbed.	If the problem occurs continuously, restart the monitor. If it still exits, contact our company for repair.
RR EXCEED	No	No	1	The circuit is disturbed and the measurement is inaccurate.	

C.2.4 TEMP Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
TEMP1 SENSOR OFF	No	Yes	3	The T1 sensor is not connected correctly to the patient or the monitor.	Check for correct connection of the T1 sensor.
TEMP2 SENSOR OFF	No	Yes	3	The T2 sensor is not connected correctly to the patient or the monitor.	Check for correct connection of the T2 sensor.
TEMP SELFTEST ERROR	No	No	1	Circuit fault of the temperature channel.	Contact our company for repair.
TEMP CALIBRATION ERR	No	No	2	Error in temperature channel calibration.	Restart the monitor. If the error remains, contact our company for repair.

C.2.5 NIBP Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
NIBP SELFTEST ERR	Yes	Yes	1	Error in NIBP initialization.	Select RESET from the NIBP SETUP menu. If the error remains, contact our company for repair.
LOOSE CUFF	No	Yes	3	The NIBP cuff is not properly connected.	Check the patient's condition, and check if the patient type is correct. Replace with a proper cuff and connect it correctly. If the problem still exists, contact our company for repair.
AIR LEAK	No	Yes	3	Leak in the airway.	
PNEUMATIC LEAK	No	Yes	3		
CUFF TYPE ERR	No	Yes	2	The cuff applied is not appropriate to the patient type.	
AIR PRESSURE ERROR	No	Yes	3	Failure occurs in the pulse measurement. The monitor cannot perform measurement, analysis,	
WEAK SIGNAL	No	Yes	3		

Alarm message	A	B	L	Cause	Measure
SIGNAL SATUATED	No	Yes	3	or calculation.	
RANGE EXCEEDED	No	Yes	3		Check the patient's condition, and check if the patient type is correct. Replace with a proper cuff and connect it correctly. If the problem still exists, contact our company for repair.
EXCESSIVE MOTION	No	Yes	3	Excessive motion of the patient's arms.	
OVER PRESSURE	No	Yes	2	The airway might be blocked.	
NIBP SYSTEM FAILURE	No	Yes	2	Failure occurs in the pulse measurement. The monitor cannot perform measurement, analysis, or calculation.	
NIBP TIME OUT	No	Yes	2		
MEASURE FAIL	No	Yes	2		
NIBP ILLEGALLY RESET	No	Yes	2	Illegal reset comes out during the NIBP measurement.	Check if the airway is blocked. Deal with the blocking and perform the measurement again. If the problem still exists, contact our company for repair.

C.2.6 Mindray SpO_2 Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
SPO2 SENSOR OFF	No	Yes	3	The sensor is disconnected from the patient or the monitor.	Make sure the sensor is placed on the patient's finger or other parts, and the monitor is connected to cables correctly.
SPO2 NO SENSOR	Yes	Yes	3	The sensor is disconnected from the patient or the monitor, or it is not properly connected.	Disconnect and reconnect the sensor as directed by the instructions. If the alarm remains, the sensor or the cable might have been damaged.
				The SpO_2 is connected upside down.	Disconnect and reconnect the sensor as directed by the instructions. Pay attention to the mark on the probe.
SPO2 LOW PERFUSION	No	No	3	The pulse signal is too weak.	Move the sensor to a site with better perfusion.

C.2.7 Masimo SpO_2 Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
SPO2 SENSOR OFF	Yes	Yes	3	The sensor is disconnected from the patient or the monitor.	Make sure the sensor is placed on the patient's finger or other parts, and the monitor is connected to cables correctly.
SPO2 PULSE SEARCH	No	No	3	The monitor is searching for the pulse signal of the patient.	If the pulse reading is not displayed after 30 seconds, check if the probe is properly connected to the patient. Change the sensor site for better signals if necessary.
SPO2 INTERFERENCE	No	No	3	The pulse signals are subject to great external interference.	Reduce or remove external interference.
SPO2 LOW PERFUSION	No	No	3	The pulse signal detected by the monitor is too weak.	Change the sensor site for better signals.
SPO2 TOO MUCH LIGHT	No	No	3	Too much light on the patient and sensor.	Turn down or off the lighting, move the probe to a place of weaker light or cover the probe.
SPO2 UNRECOGNIZED SENSOR	No	No	3	The monitor cannot recognize the SpO2 probe type.	Check for correct probe type.
SPO2 BOARD FAULT	No	No	1	The SpO2 set board malfunctions and might be unable to measure the pulse signals correctly.	Stop using the SpO2module, and contact biomedical engineers or our company for maintenance.
SPO2 SENSOR FAULT	No	No	1	The probe is damaged.	Stop using the sensor.
SPO2 NO SENSOR	Yes	Yes	3	The sensor is disconnected from the patient or the monitor, or the sensor is not properly connected.	Disconnect and reconnect the sensor as directed by the instructions. If the alarm remains, the sensor or the cable might have been damaged.
				The SpO2 probe is inserted upside down.	Disconnect and reconnect the sensor as directed by the instructions. Pay attention to the mark on the probe.
SPO2 LOW SIGNAL IQ	No	No	3	The pulse signals detected by the monitor are of poor quality.	Move the sensor to a site with better signals.
SPO2 INCOMPATIBLE SENSOR	No	No	3	The SpO2 probe is incompatible to the monitor, or is damaged.	Stop using the sensor.

C.2.8 Nellcor SpO_2 Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
SPO2 SENSOR OFF	No	Yes	3	The sensor is disconnected from the patient or the monitor.	Make sure the sensor is placed on the patient's finger or other parts, and the monitor is connected to cables correctly.
SPO2 NO SENSOR	Yes	Yes	3	The sensor is disconnected from the patient or the monitor, or the sensor is not connected properly.	Disconnect and reconnect the sensor as directed by the instructions. If the alarm remains, the sensor or the cable might have been damaged.
				The SpO2 probe is inserted upside down.	Disconnect and reconnect the sensor as directed by the instructions. Pay attention to the mark on the probe.
SPO2 INTERFERENCE	No	No	3	The pulse signals are subject to great external interference.	Reduce or remove external interference.
SPO2 BOARD FAULT	No	No	1	The SpO2 set board malfunctions and might be unable to measure the pulse signals correctly.	Stop using the SpO2module, and contact biomedical engineers or our company for maintenance.
SPO2 MOTION	No	No	3	The patient is moving.	Reduce patient motion.
SPO2 SENSOR FAULT	No	No	1	The probe is damaged.	Stop using the sensor.
SPO2 WEAK SIGNAL	No	No	3	The SpO2 signal is weak.	Change the sensor site for better signals.
SPO2 WEAK PULSE	No	No	3	The detected pulse signal is too weak.	

C.2.9 IBP Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
IBP1 SENSOR OFF	No	Yes	3	The invasive blood pressure cable of channel 1 is disconnected from the monitor.	Check if the IBP 1 sensor is properly connected.
IBP2 SENSOR OFF	No	Yes	3	The invasive blood pressure cable of channel 2 is disconnected from the monitor.	Check if the IBP 2 sensor is properly connected.
IBP1 NEED ZERO-CAL	No	No	3	The IBP transducer of channel 1 has not been zeroed.	Zero the IBP transducer of channel 1.
IBP2 NEED ZERO-CAL	No	No	3	The IBP transducer of channel 2 has not been zeroed.	Zero the IBP transducer of channel 2.

C.2.10 CO Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
TB SENSOR OFF	No	Yes	3	The cable for blood pressure measurement is disconnected from the monitor.	Check for proper connection of TB cable.

C.2.11 Mindray CO_2 Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
CO2 NO WATERTRAP	No	No	2	The water trap is not properly connected or is disconnected.	Make sure the sidestream CO_2 water trap is firmly connected.
CO2 SENSOR TEMP HIGH	No	No	1	The temperature of the sensor assembly is too high.	Restart the monitor if necessary. If the problem remains, contact our company for repair.
CO2 SENSOR TEMP LOW	No	No	1	The temperature of the sensor assembly is too low.	
CO2 AIRWAY PRES TOO HIGH	No	No	2	The pressure inside the airway is too high.	
CO2 AIRWAY PRES TOO LOW	No	No	2	The pressure inside the airway is too low.	
CO2 BAROMETRIC TOO HIGH	No	No	2	The barometric pressure is too high.	

Alarm message	A	B	L	Cause	Measure
CO2 BAROMETRIC TOO LOW	No	No	2	The barometric pressure is too low.	
CO2 HARDWARE ERROR	No	No	1	AD sampling 2.5V error	
CO2 HARDWARE ERROR	No	No	1	The pump malfunctions.	
CO2 HARDWARE ERROR	No	No	1	The 3-way stopcock malfunctions.	
CO2 SAMPLE LINE ABNORMAL	No	No	2	The sample line is abnormal or blocked.	Make sure the airway is not blocked. If the problem still exists, contact our company for repair.
CO2 CALIBRATE ZERO ERROR	No	No	1	Zeroing failure.	Restart the monitor. If the problem still exists, contact our company for repair.
CO2 USER CALIBRATE FAIL	No	No	2	User calibration failure.	Make sure the preset calibration gas concentration consists with the input calibration gas. If the problem remains, contact our company for repair.
CO2 SYSTEM ERROR	No	No	1	EEPROM reading address error.	Contact our company for repair.
CO2 SYSTEM ERROR	No	No	1	EEPROM reading length error.	
CO2 SYSTEM ERROR	No	No	1	EEPROM response to component error.	
CO2 SYSTEM ERROR	No	No	1	EEPROM checksum error.	
CO2 SYSTEM ERROR	No	No	1	External AD sample line error.	
CO2 SYSTEM ERROR	No	No	1	Internal AD sample line error.	
CO2 SYSTEM ERROR	No	No	1	Self-test error	
CO2 COMM ERROR	Yes	No	1	CO2 module communication fault.	Restart the monitor. If the problem still exists, contact our company for repair.
CO2 INIT ERR	Yes	No	1	The CO2 module is not properly installed, or malfunctions.	
CO2 COMM STOP	No	No	1	CO2 module fault or communication fault.	

C.2.12 Oridion CO_2 Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
CO2 CHECK CALIBRATION	No	No	2	Calibration error	Make sure the calibration gas is proper.
CO2 CHECK FLOW	No	No	2	Airway error	Check for leaks in the airway.
CO2 OCCLU. IN GAS LINE	No	No	2	The sampling airway has been occluded for a period of time.	
CO2 FILTERLINE OFF	No	No	2	The filter Line cannot be detected.	Check if the filter line is properly connected.
CO2 OVER RANGE	No	No	2	The CO_2 concentration value exceeds the measurement range.	Check the input gas.
CO2 REPLACE MAIN BOARD	No	No	1	CO_2 module fault.	Contact our company.
CO2 CHECK SENSOR OR PCB	No	No	1		
CO2 REPL SCRUBBER+PUMP	No	No	1		
CO2 CHANGE SENSOR	No	No	1		
CO2 15VOLT OUT OF RANGE	No	No	1		
CO2 CALIB ERROR	No	No	2	Including the error messages displayed at the lower part of the menu (like gas error, measurement error, zeroing failure, etc.)	Take measures specific to the errors. For instance, in case of a gas error, check if the gas concentration is wrong. A measurement error indicates the module is removing the occlusion or the filter line is not connected properly.
CO2 INIT ERR	Yes	No	1	An error occurs during the CO2 initialization.	Restart the monitor. If the error remains, contact our company for repair.
CO2 COMM STOP	No	No	1	Failure in communication between the CO2 module and the main board.	
CO2 COMM ERR	Yes	No	1	Error in communication between the CO2 module and the main board.	

C.2.13 Welch Allyn CO_2 Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
CO2 SENSOR OFF	No	Yes	3	The mainstream sensor is not properly connected or is disconnected.	Make sure the sensor is properly connected.
CO2 SIGNAL LOW	No	No	3	The CO_2 signal is weak.	Check for leaks in the airway. Check if the airway is clogged. Check if the water trap is too old. If all the above problems are eliminated but the problem still exists, replace with a new CO_2 tube or water trap. If the problem remains, contact our company for repair.
CO2 SIGNAL TOO LOW	No	No	3	The CO_2 signal is too weak.	
CO2 BAROMETRIC TOO LARGE	No	No	2	CO_2 module fault	Contact our company for repair.
CO2 PNEUMATIC LEAK	No	No	2		
CO2 SIGNAL NOISY	No	No	3		
CO2 SIGNAL SATURATE	No	No	3		
CO2 CALCULATION ERR	No	No	1		
CO2 SENSOR FAULT	No	No	1		
CO2 SENSOR TEMP HIGH	No	No	1		
CO2 SENSOR TEMP LOW	No	No	1	CO_2 module fault	Contact our company for repair.
CO2 WATCHDOG TIMEOUT	Yes	No	1		
CO2 SYSTEM ROM ERR 1	Yes	No	1		
CO2 FLASH CRC ERR	Yes	No	1		
CO2 INT COMM ERR	Yes	No	1		
CO2 EXT RAM ERR	Yes	No	1		
CO2 INT RAM ERR	Yes	No	1		
CO2 FLASH CHECK ERR	Yes	No	1		
CO2 STACK OVER	Yes	No	1		
CO2 PUMP FAULT	No	No	1		
CO2 REVERSE FLOW	No	No	1		
CO2 FORWARD FLOW	No	No	1		
CO2 MALFUNCTION	No	No	1		
CO2 BAROMETRIC HIGH	No	No	1		
CO2 BAROMETRIC LOW	No	No	1		

C.2.14 AG Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
AG SENSOR OFF	No	Yes	3	The AG sensor is not properly connected or is disconnected.	Make sure the AG sensor is properly connected.
AG NO WATERTRAP	No	Yes	3	The AG water trap is disconnected from the monitor.	Make sure the water trap is properly connected.
CHANGE AG WATERTRAP	Yes	No	2	The AG water trap is replaced.	Wait until the water trap has been changed.
AG WATERTRAP TYPE WRONG	Yes	No	2	The AG water trap is of a wrong type.	Replace with a water trap of a correct type.
AG USA ERROR	Yes	No	2	AG module fault.	Contact Mindray to get rid of the fault.
AG PARAMAGNETIC O2 ERR	Yes	No	1	O_2 module fault.	Contact Mindray to get rid of the fault.
AG GALVANIC O2 ERROR	Yes	No	1		
AG OXIMA DEPLETION WARN	Yes	No	2		
AG OXIMA DEPLETION ERR	Yes	No	2		
AG OCCLUSION	Yes	No	1	The actual pump rate of the AG module is <20ml/min, which exceeds 1 second.	Remove the block of the airway.
AG HARDWARE ERROR	Yes	No	1	Hardware fault of the AG module.	Contact Mindray to get rid of the fault.
AG DATA LIMIT ERROR	Yes	No	2	AG module fault.	
AG ZREF FAIL	Yes	No	3	Failure in AG module zeroing.	
AG CAL FAIL	Yes	No	1	Failure in AG module calibration.	

C.2.15 Recorder Module Alarm Messages

Alarm message	A	B	L	Cause	Measure
RECORDER INIT ERR N	Yes	No	2	An error occurs during the recorder initialization.	Contact the hospital's engineers or our customer Service.
Note: N represents the error number.					

Alarm message	A	B	L	Cause	Measure
RECORDER SELFTEST ERR	Yes	No	2	An error might occur to the RAM, ROM and CPU watchdog.	Open the RECORD menu and select the CLEAR REC TASK option. If the problem remains, contact our company for repair.
RECORDER VLT HIGH	No	No	1	A problem occurs to the system power.	If this alarm message is given for many times, contact our company for repair.
RECORDER VLT LOW	No	No	1		
RECORDER HEAD HOT	No	No	1	The thermal head of the recorder is too hot.	Resume the recording till the recorder cools down completely. If the problem still exists, contact our company for repair.
REC HEAD IN WRONG POS.	Yes	Yes	3	The thermal head of the recorder is in wrong position.	Restore the control lever of the recorder to its previous position.
RECORDER OUT OF PAPER	Yes	Yes	3	The recorder paper is used up.	Replace with a new paper roll.
RECORDER PAPER JAM	No	No	2	The recording continues for more than 30 minutes.	Place the recorder correctly and try again.
RECORDER COMM ERR	Yes	No	2	Error in recorder communication.	Open the RECORD menu and select the CLEAR REC TASK option. If the problem remains, contact our company for repair.
TOO MANY REC TASKS	No	No	2	Quite a few alarm events occur at the same time.	Check the patient's condition and the alarms. Open the RECORD menu and select the CLEAR REC TASK option. If the problem remains, contact our company for repair.
RECORDER PAPER W.P.	Yes	Yes	2	The paper roll of the recorder is not placed in the correct position.	Place the paper roll correctly.
RECORDER S. COMM ERR	Yes	No	2	Error in recorder communication.	Open the RECORD menu and select the CLEAR REC TASK option. If the problem remains, contact our company for repair.
REC NOT AVAILABLE	No	No	2	Error in the recorder work mode.	

C.2.16 System Alarm Messages

Alarm message	A	B	L	Cause	Measure
REAL CLOCK NEED SET	No	No	1	The system time is incorrect.	Reset the system time and then restart the monitor.
REAL CLOCK NOT EXIST	No	No	1	No button battery, or the battery power is depleted.	Add, or replace with a new button battery.
KEYBOARD INIT ERR N	No	No	1	Keyboard error. The keyboard cannot be used.	Contact our company for repair.
Note: N represents the error number.					
KEYBOARD ERROR	No	No	2		
NET INIT ERR (G.)	No	No	2	The system cannot be connected to the network due to problems in the monitor's network part.	
NET INIT ERR (Ram)	No	No	2		
NET INIT ERR (Reg)	No	No	2		
NET ERR (Run 1)	No	No	2		
NET ERR (Run 2)	No	No	2		
12V TOO HIGH	No	No	1	A problem occurs to the system power.	If this alarm message is given for many times, contact our company for repair.
12V TOO LOW	No	No	1		
BATTERY TOO LOW	No	No	1	The battery voltage is too low.	Connect the monitor with AC power to recharge the battery.

C.3 Prompt Messages

Prompt messages	Cause	Measure
ECG1 SIGNAL SATURATION	Signals of abrupt change interfere with the ECG signal.	Check whether the electrodes and leads are well connected.
ECG2 SIGNAL SATURATION		
SEARCH PULSE	The SpO_2 module is searching the pulse.	Wait till the end of the searching.
Welch Allyn CO2 module		
CO2 STANDBY	The CO_2 module enters the energy-saving status when switching from the Normal mode to the Standby mode.	None
CO2 WARM UP	The CO_2 module is starting and warming itself up.	Wait for the CO_2 module to finish warming itself up.
CO2 SENSOR START UP	The CO_2 sensor is starting.	Wait for the CO_2 sensor to finish the startup.
Mindray CO2 module		
CO2 STANDBY	The CO_2 module enters the energy-saving status when switching from the Normal mode to the Standby mode.	None
CO2 START UP	The CO_2 module is starting.	Wait for the CO_2 module to finish the startup.
CO2 CALIBRATE ZERO	The CO_2 module is in the zeroing status.	Wait for the CO_2 module to finish the zeroing.
CO2 WARM UP	The CO_2 module is warming itself up after startup.	Wait for the CO_2 module to finish warming itself up.
Oridion CO_2 module		
CO2 STANDBY	The CO_2 module enters the energy-saving status when switching from the Normal mode to the Standby mode.	None
CO2 START UP	The CO_2 module is starting.	Wait for the CO_2 module to finish the startup.
CO2 CALIBRATE ZERO	The CO_2 module is in the zeroing status.	Wait for the CO_2 module to finish the zeroing.
CO2 SENSOR START	The CO_2 sensor is warming itself up after	Wait for the CO_2 module to finish

Prompt messages	Cause	Measure
UP	startup.	warming itself up.
CO2 CALIBRATE	The CO_2 module is in the calibrating status.	Wait for the CO_2 module to finish the calibration.
CO2 PURGING	The CO_2 module is in the purging status.	Wait for the CO_2 module to finish the purging.
Recorder		
RECORDER INITIALIZING	The recorder is in the initializing status.	Wait for the recorder to finish the initialization.
RECORDER BUSY	The recorder is recording.	Wait for the recorder to finish the recording.
AG module		
AG STANDBY	The AG module is in the standby mode.	None
AG IS STARTING	The AG module is starting.	Wait for the AG module to finish the startup.
AG WARM UP	The AG module is warming itself up.	Wait for the AG module to finish warming itself up.
NIBP module		
Manual measure...	The NIBP module is performing the manual measurement.	Wait for the NIBP module to finish the measurement.
CONTINUAL...	The NIBP module is performing the continuous measurement.	
Auto measuring...	The NIBP module is performing the auto measurement.	
Resetting...	The NIBP module is being reset.	Wait the NIBP module to finish the resetting.
Resetting...		
Please start	This message appears after the auto measurement interval is selected.	Press the NIBP button to start the measurement.
CALIBRATE...	The NIBP module is performing the calibration.	Wait for the NIBP module to finish the calibration.
Calibration over	The calibration is finished.	None
PNEUMATIC...	The NIBP module is checking the pneumatic system for leakage.	Wait for the NIBP module to finish checking the pneumatic system.
Pneum test over	The NIBP finishes checking the pneumatic system for leakage.	None

Prompt messages	**Cause**	**Measure**
Measurement over	The NIBP button is pressed during the measurement.	None
Reset failed	The reset fails.	None
ST LEARNING	The QRS complex template for the ARR analysis is forming.	Wait till the end of the ARR learning.
ARR LEARNING		
DEFIB. SYNC.ON	The DEFIB. SYNC. switch is turned on.	It indicates that the auxiliary output port is outputting DEFIB. SYNC. signals.

Appendix D Optional Functions

The following functions are optional. You cannot use an optional function unless it is configured.

Name	Description	Operation
Dynamic Short Trends	The main screen displays the dynamic short trends.	Press the MENU button. In SYSTEM MENU, select SYSTEM SETUP >> to enter the SYSTEM SETUP menu, and then select TREND SCREEN in the FACE SELECT sub-menu.
oxyCRG (Oxygen Cardio-Respirogram)	The main screen displays the oxyCRG and the relevant information.	Press the MENU button. In SYSTEM MENU, select SYSTEM SETUP >> to enter the SYSTEM SETUP menu, and then select oxyCRG SCREEN in the FACE SELECT sub-menu.
View Bed	The main screen displays the information.	Press the MENU button. In SYSTEM MENU, select SYSTEM SETUP >> to enter the SYSTEM SETUP menu, and then select VIEWBED SCREEN in the FACE SELECT sub-menu.
Waveform Scroll	The waveforms are displayed in the scrolling manner	Press the MENU button. In SYSTEM MENU, select SELECTION >> to enter the SELECTION menu, and then set SCAN TYPE to SCROLL.
Parameter Alarm Limit	The parameter zone of the main screen displays the alarm limits of parameters.	Press the MENU button. In SYSTEM MENU, select SELECTION >> to enter the SELECTION menu, and then set ALM LIMIT to ON.
Drug Calculation and Titration Table	The system provides the function of calculating 15 drugs and displaying the titration table as well as outputting the contents of the titration table by the recorder.	Press the MENU button. In SYSTEM MENU, select DRUG CALC >> to enter the DRUG CALC menu. Then the DRUG CALC information and TITRATION information can be viewed.
Arrhythmia Analysis and ST Analysis	The patient monitor has the functions of the arrhythmia analysis and ST analysis.	Select the ECG label and press the control knob to enter the ECG SETUP menu, and then select ARR ANALYSIS >> and ST ANALYSIS >> respectively to enter the ARR ANALYSIS sub-menu and the ST ANALYSIS sub-menu.
ECG Lead Type	You can select either 3 leads or 5 leads, depending on the ECG cable used.	Select the ECG label and press the control knob. In the ECG SETUP menu, set LEAD TYPE as needed.
ECG Multi-Leads Waveform Display	The 6 displayed ECG waveforms occupy the whole waveform area or only half the waveform area. full screen.	Select the ECG label and press the control knob. In the ECG SETUP menu, select OTHER SETUP >>, and then set ECG DISPLAY to MULTI-LEADS DISPLAY or HALF-SCN MULTI-LEADS.

NIBP Groups	Multiple NIBP groups are displayed in the lower left corner of the screen.	Select the NIBP label and press the control knob. In the NIBP SETUP menu, set DISPLAY WAY to GROUPS.
Alarm Sound Off	Used to disable the alarm sound of the patient monitor.	Press the MENU button. In SYSTEM MENU, select MAINTAIN >>. Enter the user key and confirm it to enter the USER MAINTAIN menu. Then set ALARM SOUND OFF to ENABLE.
Pace maker pulse rejection	The monitor rejects pacemaker pulses that have amplitudes from -700 mv to +700 mv, pulse widths less than 2 ms and no overshoot	None
Nurse Call	The monitor alerts nurses when certain alarms are present.	Press the MENU button. In SYSTEM MENU, select MAINTAIN >>. Enter the user password and confirm it to enter the USER MAINTAIN menu. Set AUX OUTPUT to NURSE CALL, and then select NURSE CALL SETUP >>. In the NURSE CALL SETUP menu, set the parameters.
Data Output	The data can be output from the patient monitor to the PC.	Press the MENU button. In SYSTEM MENU, select SYSTEM SETUP >> to enter the SYSTEM SETUP menu, and then select DATA OUTPUT >>. In the DATA OUTPUT sub-menu, set parameters, and then select the OUTPUT button.
Large Font Screen	The monitored parameters and information can be displayed in large fonts.	Press the MENU button. In SYSTEM MENU, select the SYSTEM SETUP >> button. In the SYSTEM SETUP menu, select LARGE FONT SCREEN in the FACE SELECT sub-menu.
Defibrillator Synchronization Pulse Signal	In case of ventricular fibrillation, the defibrillator synchronization pulse signal (100ms, +5V) can be output to the defibrillator through the auxiliary output interface on the back of the patient monitor.	Press the MENU button. In SYSTEM MENU, select MAINTAIN >>. Enter the user key and confirm it to enter the USER MAINTAIN menu. Then set AUX OUTPUT to DEFIB. SYN. Then Select the ECG label and press the control knob. In the ECG SETUP menu, select OTHER SETUP >>, and then set DEFIB SYNC to ON.
Non-volatile	Measurement data can be kept in the monitor memory even after the monitor is powered off.	None

Appendix E Symbols and Abbreviations

Symbols and abbreviations that you may encounter while reading this manual or using the monitor are listed below with their meanings.

E.1 Symbols

A	ampere
Ah	ampere hour
bpm	beats per minute
BrPM	breaths per minute
℃	centigrade
cc	cubic centimeter
cm	centimeter
dB	decibel
DS	dyne.second
℉	fahrenheit
g	gram
GTT	gutta
hr	hour
hPa	hundred pascal
Hz	hertz
inch	inch
kg	kilogram
kPa	kilopascal
l	litre
lb	pound
m	meter
mcg	micrograms
mEq	milli-equivalents
mg	milligrams

min	minute
ml	milliliter
mm	millimeters
mmHg	millimeters of mercury
ms	millisecond
mV	millivolt
mW	milliwatt
nm	nanometer
ppm	part per million
s	second
V	volt
VA	volt ampere
Ω	ohm
µA	microampere
µm	micron
µV	microvolt
W	watt

-	minus
%	percent
/	per; divide; or
^	power
+	plus
=	equal to
<	less than
>	greater than
≤	less than or equal to
≥	greater than or equal to
±	plus or minus
×	multiply
©	copyright

E.2 Abbreviations

AAMI	Association for Advancement of Medical Instrumentation
AC	altenating current
ADT	adult
AG	anaesthesia gas
AHA	American Heart Association
ANSI	American National Standard Institue
AP	access point
ARR	arrhythmia
ART	arterial
aVF	left foot augmented lead
aVL	left arm augmented lead
aVR	right arm augmented lead
AwRR	Air way respiratory rate
BSA	body surface area
BTPS	body temperature and pressure, saturated
CCU	critical care unit
CH	channel
CI	cardiac index
CISPR	International Special Commmittee on Radio Interferennce
CMS	central monitoring system
cmos	Complementary Metal Oxide Semiconductor
CO	cardiac output
CO_2	carbon dioxide
COHb	carboxyhemoglobin
CPU	central processing unit
CVP	central venous pressure
D	diastolic
DC	direct current
DES	desflurane

DIA	diastolic
e.g.	for example
ECG	electrocardiograph
EEC	European Economic Community
EMC	electromagnetic compatibility
ENF	enflurane
ERR	error
ES	electrosuigical
ESU	electrosuigical unit
Et	end-tidal
$EtCO_2$	end-tidal carbon dioxide
EtN_2O	end-tidal nitrous oxide
EtO	Ethylene Oxide
EtO_2	end-tidal oxygen
EURO	European
Fi	fraction of inspired
$FiCO_2$	fraction of inspired carbon dioxide
FiN_2O	fraction of inspired nitrous oxide
FiO_2	fraction of inspired oxygen
fpga	Field Programmable Gate Array
HAL	halothame
Hb-CO	Carbonmono-xide hemoglobin
HR	heart rate
HT	height
IBP	invasive brood pressure
ICP	intracranial pressure
ICT/B	intracranial catheter tip pressure transducer
IEC	International Electrotechnical Commission
ID	invasive diastolic brood pressure
IM	invasive mean brood pressure
IS	invasive systolic brood pressure
Ins, INS	Inspired Minimum

$InsCO_2$	Inspired Minimum carbon dioxide
ISO	isoflurane
ISO	International organization for standardization
LA (L)	left arm
LAP	left artria pressure
LCD	liquid crystal display
LED	light emitting diode
LL (F)	left leg
Loop	loop read-write test fail
M	mean
MAC	minimal alveolar concentration
MAP	mean arterial pressure
MDD	Medical Device Directive
MEAN	mean pressure
MetHb	methemoglobin
Mii	initialize MII registers fail
MRI	magnetic resonance imaging
N_2O	nitrous oxide
N/A	not applied
NEO	neonate, neonatal
NIBP	noninvasive blood pressure
ND	non-invasive diastolic brood pressure
NM	non-invasive mean brood pressure
NS	non-invasive systolic brood pressure
O_2	oxygen
oxyCRG	Oxygen Cardio-respirogram
P	power
PA	pulmonary artery
PD	photodetector
PED	pediatric
PLETH	plethysmogram
PM	Patient Monitor

PR	pulse rate
PVC	premature ventricular complex
QRS	interval of ventricular depolarization
RA (R)	right arm
RAM	random access memory
RAP	right atrial pressure
Reg	test NE2000 registers fail
RESP	respiration
RL (N)	right leg
ROM	read-only memory
RR	respiration rate
S	systolic
SEV	sevoflurane
SpO_2	arterial oxygen saturation from pulse oximetry
SYNC	synchronization
SYS	systolic
T1	temperature of channel 1
T2	temperature of channel 2
TB	temperature of blood
TD	temperature difference
TEMP	temperature
TFT	Thin-Film Technology
TI	Temperature of Injectate
V (C)	precordial lead (chest)
VGA	Video Graphice Array
WT	weight